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INSTRUCTIONAL DESIGN AND ASSESSMENT

Student Preferences Regarding Teaching Methods in a Drug-Induced Diseases and Clinical Toxicology Course

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Objectives. To determine which teaching method in a drug-induced diseases and clinical toxicology course was preferred by students and whether their preference correlated with their learning of drug-induced diseases.

Design. Three teaching methods incorporating active-learning exercises were implemented. A survey instrument was developed to analyze students' perceptions of the active-learning methods used and how they compared to the traditional teaching method (lecture). Examination performance was then correlated to students' perceptions of various teaching methods.

Assessment. The majority of the 107 students who responded to the survey found traditional lecture significantly more helpful than active-learning methods ($p=0.01$ for all comparisons). None of the 3 active-learning methods were preferred over the others. No significant correlations were found between students' survey responses and examination performance.

Conclusions. Students preferred traditional lecture to other instructional methods. Learning was not influenced by the teaching method or by preference for a teaching method.

Keywords: active learning, drug-induced diseases, instructional methods

INTRODUCTION

Active learning is a well-accepted and widespread instructional method incorporated in pharmacy curricula around the country.[1] Active learning can be defined as an instructional method that engages students in the learning process through meaningful learning activities.[2] In 2009, the National Survey of Student Engagement (NSSE) recognized "active and collaborative learning" as one of its 5 key components of effective teaching. According to the NSSE report, "students learn more when they are intensely involved in their education and are asked to think about and apply what they are learning in different settings. Collaborating with others in solving problems or mastering difficult material prepares students to deal with the messy, unscripted problems they will encounter daily, both during and after college."[3] Incorporating active learning in the pharmacy curricula promotes curricular innovation, develops students as life-long learners, and supports student-centered learning.[4,5] Benefits of active learning have been studied and documented in the pharmacy education literature.[4,6,7] However, other studies have found that students were resistant to some of the teaching approaches that increase their out-of-class learning time and may not appreciate the additional workload of such teaching methods until later in their academic career.[8,9]

Arnold and Marie Schwartz College of Pharmacy and Health Sciences at the Long Island University is one of the largest private universities offering a 4-year degree in pharmacy. Approximate class size at the college is 200. Similar to many other colleges and schools of pharmacy, the curriculum has been delivered in a more traditional "teacher-focused" environment. This article describes the college's experience with implementing active-learning activities into a course on drug-induced diseases and clinical toxicology. The investigators collected information examining students' comfort level and success of learning through various teaching methods. The primary objective of this study was to define which teaching method used in the course was preferred by the students. Additionally, we examined if students' preference for a particular teaching method correlated with their actual learning of drug-induced diseases.

DESIGN

Active-learning exercises were implemented in the Drug-Induced Diseases and Clinical Toxicology course,

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a required 3-credit course offered in the spring semester of the third of 4 years. The course relies on previously acquired knowledge of physiology, chemistry, pharmacogenomics, and other biomedical sciences. This background supports acquisition of the new knowledge and skills necessary to provide patient and healthcare provider consultation and education for the prevention, detection, and management of drug-induced diseases and toxicological emergencies that may occur in clinical practice.

The nature of the course content made it suitable for higher-level active-learning exercises. In line with recommendations from the Accreditation Council for Pharmacy Education Accreditation Standards and Guidelines for the Professional Program in Pharmacy Leading to the Doctor of Pharmacy Degree (Standard 11), various active-learning methods were introduced in the drug-induced diseases portion of the course.[10] Active learning is somewhat difficult to implement in a large classroom of approximately 200 students; therefore, several approaches were tested to investigate student preference and successful delivery in this setting.[11] Active-learning methods were selected based on feasibility and best fit by topic.

Three active-learning activities were implemented, each designed to be sufficiently different to allow for evaluation of student learning preferences and student learning. The first activity involved reading a textbook chapter outside of class followed by taking a quiz and participating in a problem-based learning exercise in class (textbook chapter/quiz/PBL activity). The second involved reading an article outside of class followed by taking a quiz and participating in a problem-based learning exercise in class (article/quiz/PBL activity). The third involved listening to an audio podcast of a lecture posted online, followed by participating in a problem-based learning exercise in class (podcast/PBL activity). Additional details are provided in Appendix 1.

Audience response systems (ARSs) were used to conduct all quizzes and for individual responses during case discussions. Quiz grades contributed up to 2 extra-credit percentage points to the final course grade. All case discussions were conducted as problem-based learning (PBL) activities. For the PBL activities, students worked in self-selected groups of 3 to 4. They discussed questions in groups and then submitted their answers individually using an ARS device. Faculty members then called on individual groups to rationalize their answers. Students' participation in case discussions did not contribute to the overall course grade. An online course forum monitored/hosted by a faculty member was available for students to initiate question-and-answer sessions and topic-related discussions before or after class.

EVALUATION AND ASSESSMENT

A 14-item survey instrument was developed to obtain students' perceptions of the various teaching methods. Questions were developed to assess students' perceptions of the impact of each teaching method on their overall learning, as well as the impact of specific pre-class assignments (ie, the readings and the podcast), quizzes, and PBL cases. The survey instrument was arranged by topic and had specific examples to ensure students accurately remembered the activity upon which they were to reflect when responding to the questions. Thirteen of the 14 items were measured on a Likert scale from 1 (strongly disagree) to 5 (strongly agree). Students were also asked to provide any additional comments about their experiences with the course.

The study was reviewed and granted exempt status by the Long Island University Institutional Review Board. The survey instrument was not administered as part of an instructor or course evaluation conducted by the university. Instead, it was administered during a voluntary examination review session before the end of the semester.

In addition to the survey, 2 of the 3 multiple-choice examinations administered in the course contained 24 questions based on the material taught in the active-learning portion of the course. Of these, 15 questions were classified in the knowledge domain, 3 in the comprehension domain, 5 in the application domain, and 1 in the analysis domain of Bloom's taxonomy of educational objectives.[12,13]

Data from the survey were entered into SPSS 19.0 for Windows (SPSS, Inc., Chicago, IL). Descriptive statistics were calculated for questionnaire items from both a continuous (mean $\pm$ SD) and a categorical (percentage in agreement or disagreement) standpoint. Responses of agree and strongly agree were combined and used to calculate the percentage in agreement. Similarly, responses of disagree and strongly disagree were combined and used to calculate the percentage in disagreement. The Wilcoxon signed rank test was used to analyze ordinal data and a paired student *t* test was used to analyze continuous data. Student responses were analyzed using qualitative methods. All survey responses were anonymous.

Of the 174 students enrolled in the course, 107 attended the voluntary examination review session during which the survey was conducted. Of the 107 students invited to fill out the survey instrument, all returned completed forms (100% response rate). The majority of students were female ($\sim$70%) with a mean age of 23.5 years (demographics that are similar to the other private schools based on American Association of Colleges of Pharmacy graduating student survey data from 2012).[14]

Results of the survey are summarized in Table 1. The majority of students rated the components of the learning strategies as useful (eg, in-class quizzes, cases). However, when comparing the content delivery methods, students preferred traditional lectures over all other learning methods ($p<0.05$ for all comparisons). When comparing the quiz and PBL case components, students ratings did not differ significantly (mean of 2 quizzes, 3.8; mean of 3 PBL cases, 3.9).

In addition, students perceived that the active-learning strategies required more studying for the examination compared to traditional lecture. The last item in each of the 4 sections of the survey instrument asked students to what degree they agreed with the statement that they felt more prepared for the examination as a result of completing that particular activity (eg, 1 of the 3 active-learning activities or the traditional lecture). When only responses to this last question in each section were examined, students most strongly agreed that they felt more prepared following traditional lecture ($p<0.01$ for all comparisons). In addition, students preferred reading an article rather than reading a textbook chapter to prepare for the examination ($p=0.012$).

When responses to survey questions were combined by section to evaluate students' overall perception of each learning method, traditional lecture was found to be rated as significantly more helpful (4.0±0.9) than the textbook chapter-based (3.5±1.0), article-based (3.6±1.1), or podcast-based learning methods (3.6±1.0; $p=0.01$ for all comparisons). None of the 3 active-learning strategies were preferred over the others.

Of the 58 student comments on the survey instrument, 34 were positive (58.6%). The remaining comments did not share a consistent theme. Some expressed a preference for traditional lecture (n=4), dislike of the course format (n=4), or a perception that the course was disorganized (n=4).

Students scored highest on the examination questions that referred to content covered in the podcast (mean 81.7±21.6), although scores on the examination questions for the topics covered by the other learning methods were not significantly different (book chapter, 73.3±27.6; article, 62.3±22.8; traditional lecture 72.6±16.1). No significant correlations were found among survey results grouped by teaching method and examination performance.

DISCUSSION

Many barriers to implementing active learning have been described in the literature. These include the culture

Table 1. Student Perceptions of Usefulness of Course Structure and Activities by Topic, N=107

	Score, Mean (SD)[a]	Agree, %[b]	Disagree, %[c]
Textbook chapter-based method (pulmonary disease)			
Pre-class text reading assignment was helpful	3.5 (1.2)	57.4	24.1
In-class quiz was helpful	3.8 (1.1)	70.1	12.1
In-class cases were helpful	3.8 (1.1)	68.5	12.0
These teaching methods helped me study less for the exam since I already knew the material	3.0 (1.3)	36.4	40.2
Article-based method (cardiovascular disease)			
Pre-class article reading assignment was helpful	3.6 (1.2)	57.0	21.5
In-class quiz was helpful	3.8 (1.1)	66.4	12.1
In-class cases were helpful	3.8 (1.1)	66.4	13.1
These teaching methods helped me study less for the exam since I already knew the material	3.2 (1.2)	43.0	29.9
Podcast-based method (gastrointestinal disease)			
Pre-recorded lecture was helpful	3.7 (1.3)	65.4	17.8
In-class cases were helpful	4.0 (1.0)	74.8	10.3
These teaching methods helped me study less for the exam since I already knew the material	3.1 (1.3)	42.1	33.6
Traditional lecture method (liver disease control)			
In-class lecture was helpful	4.0 (1.0)[d]	72.9	8.4
This lecture helped me study less for the exam	4.0 (0.9)	74.8	4.7

[a] Students perceptions measured using a Likert scale on which 1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, and 5 = strongly agree.

[b] Percentage in agreement was calculated by combining strongly agree and agree responses.

[c] Percent in disagreement was calculated by combining strongly disagree and disagree responses.

[d] $p<0.05$ for all comparisons.

of the institution, as well as teacher-related and student-related barriers.[15-17] The college's culture aligns with delivering most of the pharmacy program content in a more traditional teacher-focused format, thus, the majority of in-class time is dedicated to traditional lecture. This culture may have primed students to perceive traditional learning methods as the only way to learn effectively. Because the program requires delivery of material to a large group of students (~200), implementation of active-learning strategies is challenging logistically. In this study, students preferred traditional lecture to active-learning methods in the course. Student perceptions on both content delivery and helpfulness in examination preparation favored the traditional lecture method. These findings are consistent with some previous reports.[15-17]

According to a recent study by Harpe and colleagues, 76% of students spent less time preparing for examinations following implementation of a more student-centered teaching approach.[18] We hypothesized that using active-learning methods might decrease examination preparation time; however, our study did not find this. In fact, our students felt most prepared for the examination following the traditional lecture. This finding was likely a reflection of students' familiarity with effective study routines associated with traditional lecture (or of finding examination preparation for the topics taught through active-learning activities more challenging). The discrepancy in our results may be attributable to differences in course design as well as course focus and content. The course design in the Harpe study additionally implemented optional assignments and self-reflective assignments that contributed to the grade, which may have allowed for more motivation from students.[18]

Student-related barriers to implementing active-learning methods can include lack of interest, desire, or preparedness to participate in active learning, among many others.[5,17] In this experience, students displayed lowest preference for the methods requiring out-of-class reading before class. The perceived dissatisfaction with the teaching method may stem from inadequate review of the pre-class reading assignments. Students may have felt overwhelmed and underprepared to dissect an article or a chapter on their own. In comparison with reading a textbook chapter, students perceived the article reading assignment as requiring less examination preparation, probably because the review article provided a more concise and less in-depth discussion of the subject.

The moderately positive attitudes towards quizzes and PBL cases as in-class activities probably reflected students' appreciation for learning application, allowing for better preparation for application-type examination questions. In addition, the students may have appreciated the real-life relevance of a case for exposure to identification of drug-induced diseases in a specific patient.

To further analyze if students were able to critically think and apply more challenging concepts based on implementing active learning in the class, we compared student performance on higher-level questions based on Bloom's taxonomy (application/analysis). Students scored highest on the higher-level questions related to the textbook chapter-based topic (91.86%), followed by the article-based topic (69.2%), and then the traditional lecture (51.74%) and podcast-based topic (38.95%). All comparisons among scores were significantly different ($p<0.01$). Although the number of high-level questions in each of these categories was small, it supports the idea that participation in active-learning exercises potentially contributes to development of higher-level thinking skills.

Finally, the study results emphasize that the traditional lecture is not obsolete.[19] Using a variety of teaching methods in the classroom may address the wide spectrum of students' learning styles and prevent boredom and loss of interest.[20] The key is to develop the right combination of various teaching methods to achieve optimal student learning and keep them engaged in the course and in their chosen profession.

This study had several limitations. Student preferences may have been influenced by the overall difficulty of the topic associated with each active-learning activity. Because active learning had not been previously implemented in the course, faculty members had to develop original activities and, thus, the activities may not have been optimally designed.

We encountered some barriers in implementing active-learning activities in the course. Expected barriers included the increased faculty workload compared to that required for traditional lecture[5] and the logistics of conducting small-group discussions in an amphitheater-style classroom. In addition, the online discussion forum for this portion of the course experienced high traffic volume and required significant faculty time to manage. The increase in communication between the faculty members and the students regarding comprehension of the course material may be considered an improvement given the large classroom setting in which students are easily lost. We felt that these post-class forum discussions were of great benefit to the students and provided additional opportunities for deeper learning. Although development of active-learning exercises was challenging initially, faculty workload should decrease with increased experience. Future considerations to overcome physical barriers may include reservation of several smaller classrooms or use of other areas surrounding the lecture hall. An unexpected

challenge was the technical difficulties encountered with the ARS software during lectures (eg, polling slides not displaying, students experiencing connection problems, etc). As faculty members gain more experience with using ARSs in the classroom, use of such technology will likely be less difficult.

Students generally found active-learning activities helpful, but were concerned about the increased workload associated with learning material prior to class. In order to improve student acceptance of active-learning methods, we recommend expanding the number of active-learning opportunities provided within this course and other courses throughout the curriculum. To change students' perceptions and prepare them to become life-long learners, we feel it is essential to continuously incorporate active-learning activities in relevant courses. The benefits to active-learning methods need to be shared with students so that they develop an appreciation of this teaching method and the value of acquiring lifelong learning skills.

CONCLUSION

Pharmacy students preferred traditional lecture to active-learning instructional methods for learning drug-induced diseases. Learning assessed through examination performance was not influenced by the teaching method or by the students' preference for a teaching method. Preliminary examination data suggest that some active-learning instructional methods may improve higher-level learning.

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Appendix 1. Descriptions and specific examples of active-learning exercises used in drug-induced diseases and clinical toxicology course.

	Pre-class	**In-class**
Text-book Chapter/Quiz/PBL Activity	Raissy HH et al. Chapter 36: Drug-induced pulmonary disease. In: DiPiro JT and eds. *Pharmacotherapy: a pathophysiologic approach*. 8th ed. McGraw Hill Medical 2011:511-524. **Learning objectives:** 1. Identify mechanism and recognize medications commonly implicated in the following drug-induced pulmonary diseases: • Aspirin-induced bronchospasm/aspirin-sensitive asthma • Angiotensin-converting enzyme inhibitor-induced cough • Pulmonary edema • Pulmonary fibrosis 2. Describe appropriate management of drug-induced pulmonary diseases if applicable.	**Quiz:** Sample questions (out of 4 total): • The following is true regarding aspirin-induced asthma A. Majority of aspirin-sensitive asthmatics will also react to acetaminophen B. Aspirin-sensitive asthmatics will also react to NSAIDs C. Treatment of aspirin-sensitive asthma is theophylline D. All asthmatics are intolerant to aspirin • Which of the following is true? A. ACEI-induced cough occurs in the first week of therapy B. The primary treatment for ACEI-induced cough is montelukast C. If appropriate, ACEI should be substituted with ARB in patients with ACEI-induced cough D. ACEI-induced cough occurs due to increased breakdown of bradykinin and substance P **Sample case discussions/application (20 minutes):** RT is a 60 y.o. male who presents to the clinic with history of cough, fever, and malaise. His PMH is significant for COPD and CHF. His medications at home are: Enalapril 10mg PO twice daily Metoprolol succinate 100mg PO daily Aspirin 81mg PO daily Furosemide 40mg PO twice daily Combivent 2 metered-dose inhalations 4 times/day 1. What questions would you like to ask? 2. What labs would you like to order? 3. What are the possible reasons for this patient's cough?

(*Continued*)

Appendix 1. (*Continued*)

	Pre-class	In-class
Article/ Quiz/PBL Activity	Raj SR et al. Cardiovascular effects of noncardiovascular drugs. *Circulation* 2009;120:1123-1132. **Learning objectives:** 1. Identify mechanism and recognize medications commonly implicated in the following drug-induced cardiovascular diseases: • QT prolongation, Torsades de Pointes, and Sudden Cardiac Death • Bradycardia and tachycardia • Hypotension • Hypertension • Valvular heart disease • Pulmonary hypertension • Cardiomyopathy and heart failure • Metabolic syndrome and accelerated atherosclerosis • Myocardial infarction 2. Describe the role of drug interactions in precipitating or worsening cardiovascular disease	**Quiz:** Sample questions (out of 7 total): 1. The main mechanism for drug-induced QT prolongation is A. Prolongation of cardiac action potential B. Shortening of cardiac action potential C. Increase in potassium current (I_{Kr}) D. Blockade of beta receptors 2. Which of the following combinations is/are contraindicated due to hypotension? A. Sildenafil and nitroglycerin B. Vardenafil and isosorbide dinitrate C. Tadalafil and isosorbide mononitrate D. All of the above **Sample case discussions/application (20 minutes):** A 50 year old Caucasian female presents to your pharmacy with a new prescription for Biaxin 500mg PO twice daily for 14 days. She has NKDA. In her medication profile, you find the following: Cordarone 400mg PO daily Coumadin 4mg PO daily at bedtime Zocor 40mg PO daily at bedtime Hydrochlorothiazide 25mg PO daily Her PMH is significant for atrial fibrillation, CHF, and hyperlipidemia. 1. Which drug interactions are present that may increase her risk for TdP? 2. What are the additional risk factors for TdP in this patient? 3. What is the best management for this patient's potential risk of TdP and drug interaction?
Podcast /PBL Activity	The podcast (45 minutes) was posted on Blackboard a week before the class. Students were required to review the recording prior to class to be able to participate in active learning exercise. **Learning objectives:** 1. Identify common causes of drug-induced gastrointestinal disease • Gastrointestinal bleeding • Pill esophagitis • Diarrhea– *C. Difficile*-associated diarrhea and pseudomembranous colitis • Pancreatitis • Constipation • Nausea/vomiting 2. Discuss prevention and treatment of drug-induced gastrointestinal disease	**Sample case discussions/application (40 minutes):** Case used was modified from: Williams C. Chapter 35. NSAID-Induced Ulcer Disease. In: Schwinghammer TL, Koehler JM, eds. *Pharmacotherapy Casebook: A Patient-Focused Approach*. 8th ed. New York: McGraw-Hill; 2011. **Questions that accompanied the case:** 1. What signs, symptoms, and laboratory values indicate the presence of PUD in this patient? 2. What other diagnostic test could be ordered to assess the patient's current *H. pylori* status? 3. Should this patient remain on aspirin and clopidogrel with his documented recurrent gastric ulcers? 4. What measures would you implement for monitoring the efficacy and toxicity of the treatment regimen for gastric ulcers in this patient? 5. What information should be shared with this patient about management of his gastric ulcers to enhance adherence, ensure successful therapy, and minimize adverse effects?