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Implementation of a flipped classroom model to teach psychopharmacotherapy to third-year Doctor of Pharmacy (PharmD) students

ANDREW J. MUZYK*[1], STEVE FULLER[1], MICHAEL R. JIROUTEK[2], COLLEEN O'CONNOR GROCHOWSKI[3], ANDREW C. BUTLER[4], D. BYRON MAY[1]

[1]*Department of Pharmacy Practice, Campbell University College of Pharmacy & Health Sciences, Buies Creek, North Carolina, USA.*

[2]*Department of Clinical Research, Campbell University College of Pharmacy & Health Sciences, Buies Creek, North Carolina, USA.*

[3]*Curricular Affairs, Duke University School of Medicine, Duke University, Durham, North Carolina, USA.*

[4]*Duke University Department of Psychology and Neuroscience, Durham, North Carolina, USA.*

Abstract

Objective: To implement a flipped classroom model centred on student-led active learning to teach psychopharmacotherapy in a third-year pharmacotherapeutics course.

Design: The psychopharmacotherapeutic module was conducted over a two week period during the 2014 spring semester and consisted of five class sessions. One hundred and four third-year professional Doctor of Pharmacy (PharmD) students were enrolled in the module which was taught by two instructors. Students were asked to view posted materials and to complete assignments prior to class. Class time was solely used for active learning with facilitation from the instructors. The course used individual and group readiness assessment tests (iRATs and gRATs, respectively), "muddiest point" reflection and repeated testing with open-ended questions to assess student mastery of core concepts. Pre- and post-module attitudinal surveys were administered to assess students' thoughts on three main themes centring on active learning: learning style preference, working with peers, and participating in classroom discussions.

Assessment: The overall mean test scores between 2012 (traditional lecture) to 2014 (flipped class model) demonstrated no significant difference between the time periods, as hypothesised by the study authors. Greater than 85% of students completed the pre- and post-module attitudinal surveys. Students' responses to "attitudinal questions" remained consistent in support of active learning from pre- to post-module assessment. The majority of students either "agree" or "strongly agreed" with all ten positive valence questions supporting active learning while they had mixed attitudes toward negative valence questions. Investigation of responses to "attitudinal" questions based on demographics revealed findings worth investigating in future research. Lastly, students' felt posted reading materials and group work were valuable to their learning, they were supported by their peers and instructors during class discussions and greater than 75% of class time was used for active learning.

Conclusion: A flipped classroom model was successfully implemented to teach psychopharmacotherapeutics in a third-year pharmacy therapeutics course. Students' attitudes were positive toward this teaching style prior to the start of this module and remained positive following completion. Students' reported a high level of engagement and interaction with their instructors and peers.

Keywords: *Pharmacy education, flipped classroom, psychopharmacology, active learning, team based learning*

Introduction

Psychopharmacotherapy is an ever expanding field. As advances in neuroscience provide a more detailed picture of the pathophysiology of psychiatric disorders, pharmacy students must possess a strong understanding of the pharmacology and therapeutic uses of psychotropic medications in order to become competent practitioners. Students must also develop the skills necessary to be life-long learners as the fields of medicine and pharmacology continue to evolve. In order to achieve this goal, pharmacy educators must give particular emphasis to the content of the material and to the methods used for delivering this information. Recent statement papers from pharmacy organisations and accreditation bodies strongly encourage colleges of pharmacy to develop progressive, engaging, and interactive curricula in order to cultivate

*Correspondence: Ass. Prof. Andrew J. Muzyk, *Department of Pharmacy Practice, Campbell University School of Pharmacy & Health Sciences, P.O. Box 3089 - Pharmacy, Durham, North Carolina 27710, USA. Tel: +1 919 681 3438 ; Fax: +1 919 6812741. Email: Andrew.Muzyk@duke.edu*

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independent learners who possess basic factual knowledge and the critical thinking skills necessary for therapeutic decision making (American Association of Colleges of Pharmacy, 2004; Accreditation Council for Pharmacy Education, 2011; Accreditation Council for Pharmacy Education, 2013; American College of Clinical Pharmacy, 2014). However, no consensus was found in the pharmacy literature on the best pedagogical approach for imparting this knowledge to students or the best way to develop instructors' teaching capabilities (Piascik *et al*., 2011). Although educators at numerous colleges of pharmacy across the United States (US) have moved toward active learning in their course (Stewart *et al*., 2011), many educators still grapple with how to alter courses and curricula and provide small group facilitation within large classroom lectures (Patel *et al*., 2009; DaRosa *et al*., 2011; Gleason *et al*., 2011; Farland *et al*., 2013).

The theory of adult learning known as "andragogy" describes active learning and principles consistent with the flipped classroom model. Andragogy emphasises the importance of student participation, particularly when they have some degree of experience in the subject matter being taught, versus pedagogy which focuses on lectures given by an expert who dictates what is learned with little input from student (Knowles, 1990). In order to create a flipped classroom, mutual participation between students and faculty members is critical. This includes identifying learning needs, engaging in learning activities, and evaluating the learning experience. The flipped classroom model requires students to review materials prior to class empowering them to identify learning needs and gaps in their own knowledge base (Pierce & Fox, 2012; McLaughlin *et al*., 2013; Tune *et al*., 2013; McLaughlin *et al*., 2014). An active learning environment during class allows faculty and students to assess knowledge deficits and learning needs immediately so educators can devote the entire class to identification and review of material that needs further clarification and correct misunderstandings (Van Amburgh *et al*., 2007). Lastly, a student-led active learning environment will allow students the opportunity to work in groups and share their opinions with their peers, helping them grow beyond the predominant learning style of pharmacy students which is as "convergers" and "assimilators" (Crawford *et al.*, 2012).

Educational research on the incorporation of active learning in health science programs is mixed. Several papers reported positive findings of increased student engagement, communication and team-building skills, motivation to learn, and enhancement of knowledge retention (Brookfield, 1986; Cheang, 2012; Lucas *et al*., 2013; Ofstad & Brunner, 2013), while other papers found mixed results on exam scores, student satisfaction, and peer evaluations (Haidet *et al*., 2004; Novak *et al*., 2006; Letassy *et al*., 2008; Persky, 2008; Cheang, 2009; Parmlee *et al*., 2009; Persky & Pollack, 2010; Zgheib *et al*., 2010; Grady, 2011; Persky & Pollack, 2011; Pierce, 2012; Ferreri & O'Connor, 2013; McLaughlin *et al*., 2013; Tune *et al.*, 2013; McLaughlin *et al*., 2014). The barriers of transitioning to active learning include: students' preference for and perceived benefit of lectures, instructors "outsider" role and viewing teaching as a chore with little interest, or time, in altering established course material, and institutions providing minimal support for this pedagogy with disjointed curriculums, lack of faculty development on effective teaching techniques and oversized classes with outdated classroom design (DaRosa *et al*., 2011; Gleason *et al*., 2011; Stewart *et al*., 2011).

The vast majority of pharmacy programs have already begun to implement active learning in the classroom, which underscores the importance of better understanding the effects of such a change on student learning, engagement, and satisfaction. A study by Stewart *et al*. (2011) reported that 87% of respondents to their survey of 114 pharmacy programs across the US utilised active learning techniques in the classroom. Active learning has been incorporated into numerous courses throughout the pharmacy curriculum from basic sciences (Kolluru *et al*., 2012) to physiology (Persky & Pollack, 2011) to pharmaceutics (McLaughlin *et al*., 2013) to pharmacokinetics (Persky, 2008; Persky & Pollack, 2010;) to pharmacotherapeutics (Letassy *et al*., 2008; Beatty *et al*., 2009; Cheang, 2009; Estus *et al*., 2010; Zingone *et al*., 2010; Grady, 2011; Pierce & Fox, 2012) with one college of pharmacy revamping their entire four-year curriculum around this pedagogy (Roth *et al*., 2014). However, the majority of the programs that have incorporated active learning did so in limited ways early on in their curriculum or with an elective course that may attract certain types of students. The authors found only one paper reporting on the use of a flipped class model in a third year required pharmaco-therapeutics course (Pierce & Fox, 2012). To the authors' best knowledge, the course described in this paper is the first to report on the implementation of a flipped classroom model for a required third-year psychopharmacotherapeutics course.

The authors hypothesise that a flipped classroom model can be successfully implemented to teach psycho-pharmacotherapeutics without negatively affecting students' learning or attitudes toward their learning.

Methods

The psychopharmacotherapeutic module was created for third-year pharmacy students enrolled in pharmaco-therapeutics at Campbell University College of Pharmacy & Health Science (CPHS). There were 104 students enrolled in this course. The module consisted of five class sessions held consecutively over a two-week period during the spring semester. Each session covered a different psychiatric disorder, and topics included schizophrenia, bipolar disorder, obsessive-compulsive disorder (OCD)/post-traumatic stress disorder (PTSD), generalised anxiety disorders (GAD), and major depressive disorder (MDD). One instructor and study author, Dr. Muzyk, organised the module and facilitated three of five sessions while another instructor and author,

Dr. Fuller, led the two remaining classes. This module is the first in the pharmacy curriculum to use a teaching style different than a traditional didactic lecture format. The two instructors spoke with the students about purpose and structure of the flipped classroom model at one and two months prior to its start.

Prior to the start of the module

Pre-module attitudinal survey and knowledge assessment

Students were asked to complete a 29 question survey which collected demographics, and attitudes toward active learning. Four demographic questions were collected to determine if gender, age or academic performance affected students' preference for a particular learning style. The "attitudinal" portion of this survey included 20 questions and was created by the study authors from similarly worded questionnaires published in educational research articles. No validated survey tool assessing medical or graduate health science students' attitudes toward active learning was found. Three main themes were included in this portion of the survey: learning style, working with peers, and participating in classroom discussions. Questions in this section were on a four point Likert-type scale ranging from strongly disagree (1) to strongly agree (4), omitting 'neither agree nor disagree' as a choice. The authors chose a four point Likert-type scale to force students to make a choice on these items.

The study authors adhered to the assessment tool validation process described by Burton *et al*. (2011) to develop this survey. The first two steps described by Burton *et al*. - defining the construct and item development and judgment - were completed prior to administration to the third-year pharmacy students. The questions in the "attitudinal" section were vetted through a process that included question review by Campbell University faculty from the Department of Pharmacy Practice and the College of Education. The pre-module attitudinal survey was developed in Qualtrics® and closed one-hour before the first class session of the module.

A 15 question multiple choice psychopharmacology quiz was administered to the third-year pharmacy students two weeks prior to the start of this module. The purpose of this quiz was to assess students' baseline level of understanding of psychopharmacology and psychopharmacotherapy of medications discussed in this module. Students were asked to take the quiz individually and to not use any resources; however, they were not monitored while doing so.

Course materials

Materials for all five classes were posted on Blackboard®, a web-based learning platform, two weeks prior to the start of the module. Posted material included a PowerPoint® presentation, general review articles, a question set for each respective session topic, and patient cases. The review articles and question sets were provided to enhance students' understanding of the information covered in the PowerPoint® presentations. All posted materials were mapped to the objectives for this module and toward the core psychopharmacotherapeutic concepts (determined by faculty). A link to a ten question multiple choice individual readiness assessment test (iRAT) was included on the last slide of each PowerPoint® presentation. All iRATs were developed in Qualtrics® and were closed one hour prior to the start of that respective class session. Students were asked to take the iRATs individually and to not use any resources; however, they were not monitored while doing so.

During the module

Classroom exercises

Active learning exercises were conducted during the entire class time (which ranged from two to three hours) and faculty members were asked to facilitate the students' discussion rather than provide a lecture. Students were randomly divided into four large groups (approximately 25 students per group) then further divided into smaller groups of no greater than seven. Students were asked to stay within their larger and smaller groups throughout the entire module. The specifications for group work are in keeping with the recommendations for effective team-based learning (Michaelsen *et al*., 2007; Farland *et al*., 2013). Classroom exercises were divided up amongst the four larger groups but students were asked to work within their smaller groups. A number of different active learning strategies were selected at the faculty lecturers' discretion and included team-based learning, think-pair share, debate and Socratic questioning. However, all class sessions included "muddiest point" clarification, iRAT, a group readiness assessment test (gRAT) and repeated testing with open-ended quiz questions.

The first exercise in each class session was for students to write down on an index card their "muddiest point" or the one concept they were having the most difficulty with at this point. These "muddiest points" were discussed later. Next, students were asked to bring a written copy of their responses to the iRAT completed before coming to class. Students then had to reach a consensus on what their small group thought the right answers were to each question. Through simultaneous reporting students share their group's answer to each quiz question which was compared to class results for the iRAT taken prior to that class session. The remainder of class time was used for group work on active learning exercises and for repeated quizzing with open-ended questions. Each class session had at least two in-class quizzes, that students took individually and contained questions different from those on the RATs. The final class exercise was for students to write "yes" or "no" on the same index card given to them at the beginning of class as to whether their initial "muddiest point" still existed. One instructor discussed these misunderstandings at this point in class while the other instructor discussed them in a short answer session recorded through Blackboard Collaborate® and posted to Blackboard®.

Following completion of the module

One two-hour virtual review session was hosted through Blackboard Collaborate®. Students were able to participate in the review by either logging or phoning into the session. A 39 question post-module attitudinal survey was disseminated to all the third-year pharmacy students. The first 30 questions in this survey were exactly the same as the pre-module attitudinal survey including demographics and "attitudinal" questions, but the remaining ten questions asked students to evaluate the module and their peers' participation in group work. The post-module survey was developed in Qualtrics®. The students took an examination for this pharmaco-therapeutics course of which 39 questions pertained to material taught in this psychopharmacotherapeutic module. Test questions were strongly mapped to the objectives for this psychopharmacotherapeutic module.

Statistical analysis

The primary outcome was to compare test scores from 2012 (didactic lectures) to test scores from 2014 (flipped classroom model). The authors hypothesised that there would be no difference between test scores from these two time periods. Test scores for the GAD material were omitted from this analysis since it was taught by a different faculty member in 2012. A series of two sample, independent groups (pooled) t-tests were used to test for significant differences between these two (independent) samples in regards to the overall test scores as well as each of the different psychiatric disorders discussed previously. All other information collected in this module (general student information, pre- and post-attitudinal surveys and classroom and peer evaluations) was assessed as part of the secondary study outcomes. This information was collected in a completely anonymous fashion in order to allow students to openly share their knowledge and opinions. However, since the pre- and post- module surveys were anonymous, the study authors were unable to perform any formal statistical paired comparisons of any changes in responses. Fisher's exact tests assessing the association between dichotomised survey questions of interest (strongly disagree and disagree vs. agree and strongly agree) and each of the demographic variables collected [Gender (male vs. female), Age (<25 vs. >=25), GPA (<=3.0 vs. >3.0 and PCAT score (<=50 vs. >50)] were conducted on both the pre- and post-module data. Informal comparisons of these test results were made for the pre- and post- module data. The collected pre- and post-module survey data was also summarised with frequencies (percents), means (standard deviations) and medians. The study protocol was submitted to the Duke University Hospital Investigation Review Board (IRB) and determined to be exempt as an investigation of an educational intervention. The Campbell University College of Pharmacy and Health Sciences IRB acknowledged this IRB approval. Statistical analysis was performed using SAS®, version 9.3 (SAS Institute, Cary, NC).

Results

Primary outcome

In 2012, 101 students answered 34 test questions pertaining to material taught in this module while in 2014 104 students answered 39 test questions. The test questions for these two time periods were completely different with all new test questions written for the 2014 exam but they were similar in terms of testing students' knowledge on the major concepts taught in this therapeutics module. The difference in total number of test questions between time periods is arbitrary. Analysis of the overall and individual topic mean test scores revealed no statistically significant difference in the variability of the pre- and post-module data. Therefore, pooled t-tests were used to analyse the difference in mean test scores. The mean of the overall test scores was 83.6 (95% CI; 77.9, 89.4) for 2012 and 81.7 (95% CI; 76.7, 86.8) for 2014. No statistically significant difference was observed. There was also no statistically significant difference in individual topic mean test scores between the two time periods. The results for these tests are found in Table I.

Table I: Test results for individual topics

Topic	2012 Mean (95% CI*)	2014 Mean (95% CI*)	Difference (2012 minus 2014) Mean (95% CI*)	*p*-value
Schizophrenia	81.8 (70.6, 92.9)	81.4 (71.6, 91.1)	0.4 (-13.6, 14.3)	0.957
Bipolar disorder	80.0 (63.5, 96.5)	81.3 (70.3, 92.3)	-1.3 (-18.9, 16.3)	0.877
OCD/PTSD	94.2 (86.7, 101.6)	92.7 (87.5, 97.8)	1.5 (-6.4, 9.4)	0.680
Depression	82.3 (69.1, 95.4)	76.1 (63.4, 88.8)	6.2 (-10.8, 23.1)	0.454
Overall	83.6 (77.9, 89.4)	81.7 (76.7, 86.8)	1.9 (-5.6, 9.4)	0.614

*Confidence interval

Secondary outcomes

One hundred and four students completed the 2014 module. Ninety-seven students (93.3%) completed the pre-module survey and 89 (85.6%) completed the post-module survey. Results for the "demographics" are listed in Table II. Results for the "attitudinal" questions section on both the pre- and post-module surveys are listed in Tables III and IV. Of the 20 total questions in this section, ten demonstrate a positive valence toward active learning (Table III) while ten demonstrated a negative valence (Table IV). The descriptive statistics indicate similar attitudes toward active learning prior to and following this module. Examination of the ten questions in support of active learning demonstrate that the majority of students either "agree" or "strongly agreed" with all of them. Three of ten negative valence questions

regarding active learning indicated only minority of students either "agreed" or "strongly agreed" with these statements: learned by reading on their own, judged negatively by others for sharing opinions and only interested in what the instructor teaches. The other seven negative valence questions had a slight-to-high majority of students in agreement.

Table II: Students' responses to "demographics" questions in the pre- and post- surveys

Question	Pre-module survey n=97 Percentage of responders	Post-module survey n=89 Percentage of responders
Completed surveys (total class size n=104)	93.3%	85.6%
Female sex	65.0%	62.9%
Age ≥ 25 years old	55.7%	51.7%
Current grade point average (GPA) > 3.0	65.3%	72.1%
Pharmacy College Assessment Test (PCAT) composite score > 50	82.1%	80.9%

Investigation of responses on "attitudinal" questions both pre- and post- module by gender, age, GPA and PCAT groupings revealed several findings based on age and GPA group worth describing in further detail. A significantly lower percentage of students < 25 years old (yo) compared to students > 25 yo disagreed with the statement "complex topics should only be taught in a lecture" (p=0.011) on the pre-module survey. A significantly lower percentage of students with a GPA < 3.0 compared to students with a GPA > 3.0 disagreed with the statement "I would be judged negatively by others when sharing my opinions" (p=0.002) on the pre-module survey. A significantly higher percentage of students < 25 yo compared to students > 25 yo disagreed with the following statements on the pre-module survey: "I learn best from discussing my thoughts with others" (p=0.038) and "working with others helps me respect different viewpoints" (p=0.045). No significant associations remained for the above associations on the post-module survey. Lastly, the statement "I learn about a topic by reading about it on my own" showed no significant difference on the pre-module survey between the percentages of students disagreeing with this statement based on age group but a significantly higher percentage of students < 25 yo compared to students > 25 yo disagreed with the statement on the post-module survey (p=0.049).

Table III: Students' responses to "attitudinal" questions in the pre- and post- survey; Positive valence questions

Question*	Percentage of responders ≥ 3.0 (agree)* Pre-module survey n=97 mean ± SD; median	Percentage of responders ≥ 3.0 (agree)* Post-module survey n=89 mean ± SD; median
I prefer a class that is interactive where the instructor facilitates my independent learning	73.2% 2.9 ± 0.7; 3.0	64.0% 2.8 ± 0.8; 3.0
I learn best through the application of concepts	90.7% 3.3 ± 0.6; 3.0	88.4% 3.2 ± 0.7; 3.0
Knowing I will discuss my opinions during class would motivate me to review materials prior to class	74.2% 2.9 ± 0.7; 3.0	67.4% 2.8 ± 0.9; 3.0
Practice applying concepts would prepare me for my clinical rotations	96.9% 3.5 ± 0.6; 4.0	95.4% 3.4 ± 0.6; 3.0
Practice applying concepts would enhance my understanding of a course topic	99.0% 3.4 ± 0.5; 3.0	95.4% 3.3 ± 0.6; 3.0
I feel applying concepts helped me resolve confusion I had about a topic	91.8% 3.2 ± 0.6; 3.0	72.1% 2.8 ± 0.8; 3.0
Student participation during class should be encouraged by the instructor	85.6% 3.0 ± 0.5; 3.0	84.9% 3.0 ± 0.7; 3.0
I feel my opinions would be valued in the topic discussions	68.0% 2.7 ± 0.7; 3.0	72.1% 2.8 ± 0.7; 3.0
Working with others would help me respect different viewpoints	79.4% 2.9 ± 0.7; 3.0	72.1% 2.8 ± 0.8; 3.0
I learn best from discussing my thoughts with others	58.8% 2.6 ± 0.9; 3.0	57.0% 2.5 ± 0.9; 3.0

* Likert-type scale with 1 strongly disagree; 2 disagree; 3 agree; 4 strongly agree

Students' opinions toward the module and their peers were evaluated on the final ten questions of post-module attitudinal survey. The majority of students reported spending two hours or less to prepare for class, reviewed some-to-most of the posted reading materials and felt reading materials prepared them for classroom discussions. Of the posted materials, PowerPoint® presentations were used the most to prepare for class followed by question sets, iRATs and review articles (in this order). Peer evaluations reported strong agreement with statements about the benefit of group work and equal

contribution within their small groups. Students felt strongly that instructors encouraged them to participate in classroom discussions and felt supported when they did. Lastly, students reported that greater than 75% of class time was spent performing active learning exercises.

Table IV: Students' responses to "attitudinal" questions in the pre- and post- survey; Negative valence questions

Question*	Percentage of responders ≥ 3.0 (agree)* Pre-module survey n=97 mean ± SD; median	Percentage of responders ≥ 3.0 (agree)* Post-module survey n=89 mean ± SD; median
I would like a lecture even if lecture materials were available prior to class	92.8% 3.3 ± 0.6; 3.0	93.0% 3.4 ± 0.8; 4.0
Complex topics should only be taught in a lecture	61.9% 2.8 ± 0.8; 3.0	68.6% 2.9 ± 0.8; 3.0
I learn best from a lecture	66.0% 2.9 ± 0.8; 3.0	76.7% 3.0 ± 0.8; 3.0
I am too busy to review materials prior to class	58.8% 2.7 ± 0.7; 3.0	60.5% 2.8 ± 0.8; 3.0
I learn about a topic by reading about it on my own	40.2% 2.3 ± 0.9; 2.0	39.5% 2.2 ± 0.9; 2.0
I feel a lecture would best prepare me for a test	69.1% 3.0 ± 0.8; 3.0	81.4% 3.2 ± 0.8; 3.0
I feel a lecture would challenge my understanding of a topic	56.7% 2.6 ± 0.7; 3.0	59.3% 2.7 ± 0.7; 3.0
I worry that the instructor would call on me in class	77.3% 3.1 ± 0.8; 3.0	70.9% 3.0 ± 1.0; 3.0
I would be judged negatively by others when sharing my opinions	44.3% 2.5 ± 0.8; 2.0	48.8% 2.6 ± 0.9; 2.0
I am only interested in what the instructor teaches me	28.9% 2.3 ± 0.7; 2.0	36.1% 2.4 ± 0.8; 2.0

* Likert-type scale with 1 strongly disagree; 2 disagree; 3 agree; 4 strongly agree

Ninety-nine students (95.2%) took pre-module psychopharmacology quiz and the mean score was 46.7 + 1.4 out of a total of 100 points. Greater than 75% of students took the readiness assessment quizzes prior to each class. Results from these quizzes demonstrated that the majority of students were able to answer these questions correctly following review of posted materials. The mean score on all five iRATs was 78.1 + 13.4.

Discussion

This study demonstrated the successful implement a flipped classroom model into a pharmacy therapeutics course. Despite the radical change in pedagogy from students' previous three-and-a-half years of education, there was no detrimental effect on students' exam scores and their attitudes and participation were positive toward student-led active learning. Class time was utilised to build upon core concepts that students acquired through review of material posted prior to each class allowing them to apply their new knowledge to exercises rooted in "real world" clinical problems. Students were constantly challenged with different clinical questions and asked to develop an opinion then defend it to their group or to the entire class. The use of question sets, case vignettes and in-class quizzes provided students with numerous opportunities to apply newly gained knowledge and allowed faculty the real-time opportunity to correct misunderstandings. "Muddiest point" reflection exercises as well as Blackboard Collaborate® review sessions provided additional opportunities for students to express knowledge deficits and for faculty to intervene. In classroom and peer evaluations the majority of students "strongly agreed" with feeling encouraged and supported to contribute to classroom discussions by faculty and their peers and that everyone contributed equally and added benefit to group work.

Overall, the responses to "attitudinal" questions revealed a higher percentage of students "agreed" or "strongly agreed" with positive valence statements in support of this pedagogy compared to negative valence ones. Attitudes remained consistent in support for active learning from pre- to post- module. Positive valence statements show an overwhelmingly high percentage of students felt application of concepts in class and facilitation of their learning would help them better understand course topics and prepare them for future practice. Students also agreed that they should be encouraged to participate in discussions and would feel supported by their peers.

Examining the negative valence statements shows a remaining reliance of students on lectures with increased percentage of them still wanting a lecture post-module being interested only in what the instructor teaches. This is a common theme where students see value in active learning but are hesitant to give up the "crutch" of a lecture. Haidet *et al*. (2004) hypothesised that these contradictory perceptions of value occur for two main reasons: emphasise on the legitimacy of didactic lecture and the newness other instructional methods and the reliance of students on an expert to interpret and explain concepts. Early and often exposure to active learning may be needed before students fully understand its true value. Future research should explore the influence of student demographics on learning styles is needed. This study found students < 25 yo and with a GPA < 3.0 were initially less receptive toward several statements regarding active learning compared to their counterparts, although significance was lost post-module.

Despite students feeling too busy to work outside of the classroom, they were completely invested in the course both in and out of classroom. Students reported spending up to two hours reviewing posted materials prior to each class session with many of them using several of them to prepare for class and greater than 75% of students

completed each iRAT. PowerPoint® slide sets were viewed the most by students. Although the posted materials were helpful as evidenced by the increase in scores from the pre-module psychopharmacology quiz to the iRATs, a future iteration of this module will move away from using slide sets prepared by instructors toward more engaging materials to help students' better assess their knowledge and prepare them to discuss clinical scenarios. Additionally, group work outside of class will be required so that class time can be used more efficiently to discuss students' opinions and to increase student participation in the discussion. Papers on flipped classroom models have tackled this issue with Pierce et al. using video podcasts (vodcasts) (Pierce & Fox, 2012) while McLaughlin et al. (2013, 2014) discuss the use of self-paced interactive learning accelerator modules (iLAMs) in combination with readings. Students stated that a substantial portion of class time was spent performing active learning exercises, which an independent audit of the bipolar disorder class session by two faculty members, not associated with this module, confirmed the high-level of interaction and engagement between students and instructor. Although the instructors were successfully able to break a large classroom of 104 students into smaller groups of no more than seven, additional ways to improve the interactions between student-to-student and student-to-instructor will be explored to make sure all students are engaged in the learning process.

The lack of a significant difference in test scores between the two different time periods, and their respective pedagogies confirmed the authors' hypothesis and is viewed by the authors as support for the successful implementation of an unfamiliar pedagogy into a traditional curriculum. The authors took the conservative approach to this primary outcome since our module required students to drastically change their role in the classroom as well as how they were taught and learned material. The instructors were challenged to write new exam questions since old questions were used to create the iRATs and in-class quizzes for the current module. Students' scores improved from the pre-module psychopharmacology quiz to iRATs to exam questions.

The value of exam score changes as a marker of success can be misleading and minimally valuable when measuring the true impact of learning and retention, especially concerning knowledge gained in active learning (Persky, 2008; Lucas et al., 2013). For this reason, the authors incorporated repeated testing into each class session with multiple quizzes and will test students at several points throughout of the remainder of their third- and fourth- years to test knowledge retention. Numerous studies, outside of pharmacy literature, have demonstrated the beneficial impact of repeated testing on these learning outcomes both in laboratory (Larsen *et al*., 2008; Larson *et al*., 2009) and classroom studies (Blouin *et al*., 2009; Roediger & Butler, 2011; Zellmer *et al*., 2013; Stewart *et al*., 2014).

We developed this module in response to recent publications in the pharmacy education literature challenging schools of pharmacy to change pedagogical teaching exercises to more active learning strategies with the goal of graduating pharmacy students who are not only competent to pass the national boards but who are also critical and creative thinkers capable of adapting to the constantly evolving clinical and medical arena. Blouin *et al*. (2009) describes three areas of focus to improve pharmacy education in the 21st century. These emphasise challenging students to think critically to understand the purpose (why), content (what), and methods (how) regarding health care issues, communicate lucidly and synthesise broadly to solve problems, and to create an "evidence-based education" philosophy. This module focused on these three areas by using practical case vignettes and question sets, asking students to tackle difficult clinical questions and to defend their answers, and implementing proven active learning exercises described in the pharmacy and medical literature.

Recommendations for the next generation of accreditation standards for Doctor of pharmacy education provided by Zellmer *et al*. (2013) centre on the implementation of innovative strategies to transition education from knowledge acquisition to knowledge application in order to prepare graduates to have an impact on patient care (Graham *et al*., 2007). In fact, several recommendations rated "high impact/high feasibility" by > 51% of respondents surveyed at the 2012 American Council for Pharmacy Education Conference on Advancing Quality of Education (and important to this paper) included improving communications skills, employing active learning and collaborative-learning methods in the curriculum. These recommendations foster innovative curricular development and delivery, cultivating behavioural attributes such as clinical reasoning, critical thinking skills and leadership. Since many pharmacy employers expect newly-hired pharmacists to possess entry-level competencies for their first jobs, it is important to bring pharmacy education up to speed in terms of fostering active, life-long learning strategies (Cain *et al*., 2009).

The current study has a number of limitations. First, instructors were not required to adhere to a specific type or frequency of active learning exercises, and there was no formal assessment of the quality or consistency of active learning. Second, student response rate to the attitudinal surveys, evaluations and quizzes was less than 100%. Though anonymity was a necessary component to permit students to explore the active learning strategies without coercion or retribution, it is not possible to determine whether there were any systematic differences in the type of student who completed measures compared with students who did not. Additionally, we did not use an audience response system in this feasibility module; it is possible that the use of an audience response system would further increase the engagement and interaction of students. Audience response systems have been successfully implemented in pharmacy courses and have been reported to increase the engagement and interaction of students (Clauson *et al*., 2012). Anonymity also prevented the study authors from performing paired

comparisons on several different measures from student data collected during this study. Exam questions from the two time periods described in this paper tested students on similar concepts but were completely different types of questions which limit a direct comparison on this measure. Students were different in the two time periods. Finally, because the active learning strategy was employed in an entire cohort of students without randomisation, we were limited in our assessment of student knowledge acquisition to historical comparison with test scores from the year prior to implementation of the andragogical model. Because other factors may contribute to student test performance, it is not possible to compare knowledge acquisition among these students with the different educational strategies.

Summary

A flipped classroom model was successfully implemented during a third-year pharmacy therapeutics course. Students' attitudes were positive toward this teaching style prior to the start of this module and remained positive following module completion. Key accomplishments of this module were the promotion of self-directed learning, student accountability, application of newly gained knowledge, engaging in critical and creative thinking, and working in teams to problem solve. The active learning strategies used in the module were intended to help learners develop the skills to become competent pharmacists and were developed in keeping with pharmacy education recommendations posited by key thought leaders in AACP and ACPE.

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