

RESEARCH ARTICLE

Flipped-classroom approach to teach deprescribing and safe medication use in a geriatric pharmacotherapy module

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Abstract

Objective: To assess the impact of a flipped-classroom approach to teach safe medication use and deprescribing for older adults on student academic performance and perceptions of deprescribing. **Methods:** This was a pre-post evaluation following implementation of the flipped-classroom approach in a third-year pharmacotherapy course. The primary endpoint was the difference in exam performance on ten related assessment items. An electronic survey was distributed to students in both cohorts to assess their attitudes, perceived ability, and confidence in deprescribing (five-point Likert-scale). **Results:** The average score on covered exam items was 74.6% in the lecture group and 75.6% in the flipped-classroom group ($p = 0.62$). Students in the flipped-classroom group were more likely to endorse confidence in their ability to recommend appropriate deprescribing strategies for potentially inappropriate medications ($p = 0.02$). **Conclusion:** Learners reported increased self-confidence with deprescribing in practice when taught using the flipped-classroom approach, but exam scores were not significantly improved.

Introduction

It is estimated that over 20% of adults in the United States (US) will be over the age of 65 years old by the year 2030 (Odegard *et al.*, 2007). Adequate exposure to geriatric pharmacotherapy concepts is crucial to ensure new graduating pharmacists are practice ready to care for these patients (Institute of Medicine, 2008). Previous studies spanning several decades have consistently shown that the extent to which geriatric content is taught at US schools of pharmacy has not kept pace with the expanding population of older adults (Dutta *et al.*, 2005; Jimenez, 2012; Odegard *et al.*, 2007; Woodall *et al.*, 2022). A 2014-15 survey of US schools and colleges of pharmacy found that schools spent a median of six contact hours teaching geriatric pharmacotherapy (Woodruff *et al.*, 2018). Medication use in older adults, including concepts such as

polypharmacy, potentially inappropriate medications (PIMs), and dose de-escalation was a Tier 1 (highest priority) topic for inclusion in school of pharmacy curricula in the 2009 and 2016 American College of Clinical Pharmacy (ACCP) Pharmacotherapy Didactic Toolkits (Schwinghammer *et al.*, 2016). Deprescribing, the clinician supervised withdrawal of medications in which potential harms outweigh the benefits, first appeared in the 2019 update to the ACCP Pharmacotherapy Didactic Toolkit (Flannery *et al.*, 2020). Deprescribing is a complex task that entails interprofessional care and involves shared decision making with patients and caregivers (Zimmerman *et al.*, 2019). Recent surveys conducted in the US and Great Britain identified opportunities to improve coverage of deprescribing concepts in school of pharmacy curricula (Barnett *et al.*, 2021; Clark *et al.*, 2020). The optimal methods for teaching this concept to student

pharmacists are poorly understood (Springer *et al.*, 2022).

The flipped-classroom is an instructional method that is gaining popularity in health professional education (Persky & McLaughlin, 2017; Rotellar & Cain, 2016). This approach involves students completing pre-class learning assignments to cover foundational concepts and using class time for active learning, where foundational concepts can be reinforced and more complex problems introduced, under the guidance of the instructor. A variety of pre-class instructional methods have been studied in the flipped-classroom model, including pre-recorded videos, reading assignments, and interactive online modules (Han & Klein, 2019). Previous studies have suggested that use of the flipped-classroom in pharmacy education may lead to improved student learning compared to traditional teaching methods (Gillette *et al.*, 2018; Goh & Ong, 2019; Koo *et al.*, 2016; Prescott *et al.*, 2016). While the flipped-classroom approach has not been previously reported to improve geriatric pharmacotherapy competencies among student pharmacists, studies among medical and nursing students have suggested a positive impact on knowledge, attitudes, and course satisfaction (Dabney & Mitchell, 2017; Granero Lucchetti *et al.*, 2018). The purpose of this project was to implement and assess the impact of a flipped-classroom approach to teach safe medication use and deprescribing for older adults on student learning and attitudes, perceived ability, and confidence in deprescribing.

Methods

This study utilised a quasi-experimental pre- and post-test nonequivalent groups design. Third year students at the University at Buffalo School of Pharmacy and Pharmaceutical Sciences enrolled in the geriatric pharmacotherapeutics module during 2019 and 2020 were included in this study. In 2019, the topics of safe medication use and deprescribing for older adults were covered utilising a traditional lecture format. This included assignment of required readings and a live, 80-minute lecture. In 2020, a flipped-classroom approach integrating case-based learning replaced lectured-based delivery. Students were required to view two online videos introducing safe medication use (19 minutes) and deprescribing (13 minutes) and were assigned required readings prior to the scheduled class period (American Geriatrics Society, 2019; O'Mahony *et al.*, 2015; Scott *et al.*, 2015). During class, students worked in groups of five to six students to complete a case-based active learning exercise focused on identifying potentially inappropriate

medications and making recommendations for deprescribing. Pedagogical techniques used in each cohort are outlined in Table I.

Table I: Comparison of teaching design for lecture and flipped-classroom based

	Lecture	Flipped-classroom
Pre-class material		
Pre-recorded video	No	Yes
Lecture notes/slides	Yes	Yes
Learning outcomes	Yes	Yes
Required readings	Yes [*]	Yes
Supplemental readings/resources	Yes	Yes
In class activity		
In-person lecture [†]	Yes	No
Case-based learning [‡]	No	Yes
Post-class		
Discussion board thread	No	Yes
Assessment		
Summative evaluation of patient case [¶]	No	Yes
Unit examination	Yes	Yes

^{*} Required readings were specified in the course syllabus, but no readiness assessment required in class

[†] Eighty minute lecture

[‡] Students given 50 minutes to complete case questions in groups and 30 minutes of faculty facilitated case discussion

[¶] Case includes 6 open-ended questions and was worth a maximum of 10 points

The primary endpoint was the difference in exam performance on ten related assessment items on the unit exam. This included eight multiple choice questions (one of which asked students to select multiple correct answers to a single question) and two true or false questions. The same exam questions were used each year to allow for direct comparison. Per policy, students were invited to attend an exam review, but exams were not returned to students. Scores for all exam takers in each year were assessed with descriptive statistics and compared between groups with an unpaired Student's t-test. Question performance was also assessed across Bloom's taxonomy levels to evaluate differences in lower (knowledge/comprehension, n = 3) versus higher (application/synthesis, n = 7) order questions as assigned a priori by one of two instructors in the course (Bloom, 1956). To assess the need to control for baseline differences in student's academic performance across years, the overall exam grades for the two other unit exams within this course (one pediatric pharmacotherapy and an unrelated geriatric

pharmacotherapy exam) were compared with an unpaired Student's t-test.

As a secondary endpoint, an electronic survey was distributed to both class years to assess student attitudes toward and ability and confidence in identifying PIMs and deprescribing on a five-point Likert scale (5 = strongly agree, 4 = agree, 3 = neither agree nor disagree, 2 = disagree, 1 = strongly disagree). Percentage agreement to individual items was compared using chi-squared or Fisher's exact test as appropriate for individual survey items. These items were grouped into three scales calculated as the average of the responses for that scale. The methodology for the development of the survey and scaled scores used in this study have been published elsewhere (Clark et al., 2020). Cronbach's alpha (α) was calculated as a measure of scale reliability for each. An alpha of 0.70 is considered minimally acceptable and over 0.80 is considered indicative of high internal consistency (Tavakol & Dennick, 2011). Scale scores were compared across groups with an unpaired Student's t-test. Survey responses were retained for analysis if at least 75% of the items for each scale were complete. Cohen's *d* was calculated as a measure of effect size for all t-test comparisons in this study. Cohen *d* values less than 0.2 were considered very small and meaningless; greater than 0.2 and up to 0.5 were considered small but meaningful; greater than 0.5 and up to 0.8 were considered medium; and greater than 0.8 were considered large (Cohen, 1988). Students in the flipped-classroom group were also asked questions regarding their perceptions of the instructional methods using the same Likert-scale.

All statistical tests were two-tailed with an a priori alpha level of 5%. Statistical analysis was performed with SAS version 9.4 (SAS Institute, Cary, NC). This study was deemed exempt by the Institutional Review Board at the University at Buffalo.

Results

This study included 117 students in the lecture group and 116 in the flipped-classroom group. There were no between-group differences in performance on other exams in the same course, which covered pediatric and geriatric pharmacotherapy topics. The mean (SD) score on the pediatric pharmacotherapy exam was 89.3% (9.1) and 89.8% (8.5) for the lecture and flipped-classroom groups, respectively ($p = 0.69$). The mean (SD) score on the separate geriatric pharmacotherapy exam was 90.3% (6.9) and 89.3% (7.5) for the lecture and flipped-classroom groups respectively ($p = 0.30$). As

no differences were found, the authors did not adjust the primary analysis.

For the primary endpoint, the mean (SD) score on exam items related to safe medication use and deprescribing for older adults was 74.6% (15.2) and 75.6% (15.0) for the lecture and flipped-classroom groups respectively ($P = 0.62$). Cohen's *d* was 0.07 demonstrating a very small and meaningless effect size. There was no difference in performance on exam questions when categorized by Bloom's taxonomy levels: 98.7% versus 99.4% knowledge/comprehension items ($p = 0.42$, Cohen's *d* = 0.11) and 64.2% versus 65.4% application/synthesis items ($p = 0.68$, Cohen's *d* = 0.05) were answered correctly in the lecture and flipped-classroom groups, respectively.

The usable response rate for the survey instrument was 20.5% in the lecture group and 19.0% in the flipped-classroom group. Although eight of nine items included in the deprescribing ability and confidence scales were numerically higher in the flipped-classroom group, there were only two items that were statistically significant between groups (Table II). Those in the lecture group more frequently agreed that they would be comfortable recommending deprescribing strategies for potentially inappropriate medications to a medical provider (100% versus 81.8%; $p = 0.04$). Those in the flipped-classroom group more frequently agreed that they were confident in their ability to recommend appropriate deprescribing strategies for potentially inappropriate medications in clinical practice (54.2 versus 86.4; $p = 0.02$).

The deprescribing attitudes scale did not demonstrate reliability with a Cronbach's α of 0.57. The deprescribing ability and confidence scales demonstrated acceptable reliability with Cronbach's α of 0.84 and 0.79 respectively. Those in the flipped-classroom group had higher mean scores on each of the three scales, however, the difference was not statistically significant (Table III).

There were 21 (18.1%) completed responses for the questions related to perceptions of the instructional methods in the flipped-classroom group (Table IV). The majority of responding students agreed that the pre-recorded videos contributed to their learning. However, only one-third of respondents preferred the pre-recorded lectures compared to a traditional lecture. More than 80% of respondents agreed that watching the pre-recorded videos was necessary to contribute to the case-based learning activity and that the case-based learning activity contributed to their learning.

Table II: Comparison of attitudes, ability and confidence regarding deprescribing

Question	Lecture Positive agreement n = 24; n(%)	Flipped- classroom Positive agreement n = 22; n(%)	p value
Deprescribing Attitudes Scale			
Inappropriate prescribing may result in poor health outcomes for older adults	24 (100)	22 (100)	-
Deprescribing potentially inappropriate medications is valuable to patients	24 (100)	21 (95.5)	0.48 *
Pharmacists play an important role in identifying and assisting with deprescribing of potentially inappropriate medications in clinical practice	24 (100)	22 (100)	-
Deprescribing Ability Scale			
I am able to identify potentially inappropriate medications in clinical practice	22 (91.7)	22 (100)	0.49 *
I am able to educate older patients regarding the risk of harm related to potentially inappropriate medications	19 (79.2)	19 (86.4)	0.70 *
I am able to select appropriate alternative medications and non-pharmacologic treatment options for inappropriate medications in older adults	16 (66.7)	20 (90.9)	0.07 *
I am able to assess medications for potential risk and expected benefits in older adults	20 (83.3)	21 (95.5)	0.35 *
I am able to devise a tapering schedule for medications that may cause withdrawal symptoms with abrupt discontinuation	15 (62.5)	16 (72.7)	0.46 †
Deprescribing Confidence Scale			
I am comfortable recommending deprescribing strategies for potentially inappropriate medications to a medical provider	24 (100)	18 (81.8)	0.045 *
I am confident in my ability to recommend appropriate deprescribing strategies for potentially inappropriate medications in clinical practice	13 (54.2)	19 (86.4)	0.02 †
I am confident in recommending deprescribing of preventative medicines in elderly patients when life expectancy no longer justifies potential benefits	14 (58.3)	18 (81.8)	0.08 †
I am confident in recommending the deprescribing of guideline recommended therapeutic medications in elderly patients with poor life expectancy	13 (54.2)	17 (77.3)	0.10 †

* Per Fisher's exact test

† Per chi-squared test

Table III: Assessment of scale reliability and comparison between groups

	Cronbach alpha (α) *	Lecture Mean (SD)	Flipped-classroom Mean (SD)	p value	Cohen's d	Magnitude of effect †
Deprescribing Attitudes Scale	0.57	4.81 (0.29)	4.82 (0.35)	0.90	0.04	Very small
Deprescribing Ability Scale	0.84	3.88 (0.66)	4.14 (0.56)	0.17	0.41	Small
Deprescribing Confidence Scale	0.79	3.71 (0.70)	3.97 (0.56)	0.18	0.40	Small

* Cronbach alpha (α) reliability of 0.70 or above are considered generally acceptable for evidence of reliability for instruments with low stakes

† d <0.2 is considered a very small effect size; d between 0.2 and 0.5 is considered small, d between 0.5 and 0.8 is considered medium, and d >0.8 is considered large

Table IV: Perceptions of instructional methods used in flipped-classroom *

Item [†]	Disagree [‡] n (%)	Neutral n (%)	Agree [§] n (%)
Learning key foundational content prior to coming to class enhanced my learning of course material during class	4 (19.1)	6 (28.6)	11 (52.4)
The online videos contributed to my learning	3 (14.3)	4 (19.1)	14 (66.7)
The assigned readings contributed to my learning	5 (23.8)	7 (33.3)	9 (42.9)
Case-based learning contributed to my learning	1 (4.8)	3 (14.3)	17 (81.0)
I preferred viewing online videos prior to class more than attending traditional live in-class lecture	9 (42.9)	5 (23.8)	7 (33.3)
Viewing the online videos before class prepared me for case-based learning	3 (14.3)	5 (23.8)	13 (61.9)
I needed to view the online videos in order to contribute to my group's discussion during case-based learning	2 (9.5)	0 (0.0)	19 (90.5)

* Out of 21 completed responses

† Rated on a scale of 1 to 5 on which 1 = strongly disagree, 2 = disagree, 3 = neither agree nor disagree, 4 = agree, 5 = strongly agree

‡ Includes disagree and strongly disagree

§ Includes agree and strongly agree

Discussion

Identification of PIMs and deprescribing requires strong clinical skills and an ability to work as part of an interprofessional team (Zimmerman *et al.*, 2019). To the authors' knowledge, this is the first study that has assessed the impact of implementation of a flipped-classroom approach to teach geriatric medication safety and deprescribing. Contrary to this study's hypothesis, implementation of the flipped-classroom and case-based learning activity did not lead to improved student performance. While the flipped-classroom approach has not been previously reported to improve geriatric pharmacotherapy competencies among student pharmacists, a study by Granero Lucchetti and colleagues suggested this approach improved knowledge, attitudes, and course satisfaction among third year medicine students, but did not lead to improved performance with a standardised patient (Granero Lucchetti *et al.*, 2018). These findings are comparable to the results of this study as the authors did see increased student self-confidence in deprescribing in practice, but did not see an objective improvement on exam performance.

Previous studies have demonstrated improvement in academic outcomes following implementation of the flipped-classroom, (Goh & Ong, 2019; Koo *et al.*, 2016; Prescott *et al.*, 2016; Wilson *et al.*, 2019) while other have shown no improvement relative to a traditional lecture format (Smith *et al.*, 2018). A meta-analysis by Gillette and colleagues suggested that the flipped-classroom may lead to a small positive effect on academic performance (Gillette *et al.*, 2018). A recent qualitative study of student pharmacists suggested that increased opportunities for hands on experience with deprescribing would be helpful to empower them with the knowledge and experience they need for clinical practice (Springer *et al.*, 2022). Increasing student's exposure to deprescribing through simulation, case-based activities, and experiential rotations throughout the curriculum may be necessary to improve performance in this area going forward.

The findings suggest that instruction with the flipped-classroom led to increased self confidence in ability to deprescribe relative to those instructed in the traditional classroom setting. The authors hypothesise this is primarily due to the case-based learning activity which gave the students an opportunity to develop deprescribing recommendations for a simulated patient. Several previous studies have suggested that instruction utilising a flipped-classroom can improve students' self-confidence in competencies (Goh & Ong, 2019; Smith *et al.*, 2018; Trovato *et al.*, 2019). Goh and Ong (2019) found that just over half of students engaged in the flipped-classroom reported feeling more confident

answering exam questions. Smith and colleagues (2018) found that while student reported confidence in treatment-planning and patient counseling increased, there was no improvement in final exam grades within a self-care therapeutics course utilising a flipped-classroom approach. Trovato and colleagues (2019) conducted a pre-post survey to assess change in student's confidence in oncology competencies following implementation of a flipped-classroom course and found that this method improved student confidence in all competency areas. However, a significant limitation to these studies is the lack of comparison to a control group that used a traditional lecture, an aspect that was accounted for in this study design. This authors did note that the lecture group reported a higher level of agreement to being comfortable making deprescribing recommendations to a provider. The reason for this is unclear as interprofessional communication was not covered through either delivery method. These results are likely due to unmeasured differences between the study groups.

The authors found mixed results regarding student opinions of the pedagogical methods used in the flipped-classroom delivery. A combination of online lecture videos, required readings, and in-class case-based learning was utilised in the flipped-classroom group to maximise usefulness to students with different learning styles. While the majority of responding students agreed that the online videos and the case-based learning activity contributed to their learning, less than half of respondents felt the assigned readings contributed to their learning. Only one-third of students reported preferring online lecture videos to a traditional lecture, which the authors hypothesised could be due to perceived additional workload. The results related to the perceived benefit of pre-class online videos and case-based learning are similar to the findings reported by Prescott and colleagues (2016) relating to the implementation of a blended learning model for instruction in a patient assessment course. Previous studies have also suggested that students may not prefer readings as pre-class work in a flipped-classroom setting. Smith and colleagues (2018) found that students in the post flipped-classroom group were less likely to agree that assigned readings greatly enhanced their learning. Han and Klein (2019), conducted a literature review of pre-class learning methods used for flipped-classroom approaches and found little data to support what types of activities correlate with student performance. Future studies are needed to assess pre-class and active learning activities that may improve student's ability to deprescribe.

Strengths and limitations

The primary strength of this study was inclusion of a control group that allowed for direct comparison of both exam performance and student perceptions of their ability to deprescribe. This study has limitations that should be noted. While the authors attempted to assess for differences in academic aptitude by comparing previous exam performance between groups, confounding factors, such as differences in student demographics, learning styles, and clinical experiences, may still have been present. Additionally, we did not track number of views of the pre-recorded lecture prior to the in-class exercise. Due to the coronavirus disease 2019 pandemic, those in the flipped-classroom group were administered the examination remotely using ExamID and ExamMonitor available through ExasmSoft (ExamSoft Worldwide, Inc., Dallas, Texas). While this software provides safeguards against academic dishonesty, the impact of administration modality on exam performance cannot be ruled out. The response rate for the survey instrument was low in both groups, increasing the risk for nonresponse bias: Our data may therefore not be generalisable to the entire class.

Conclusion

The flipped-classroom approach, which included pre-class videos and in-class case-based learning, increased student self-confidence in deprescribing in practice, but did not lead to improved exam performance on items related to safe medication use in older adults and deprescribing. Only one-third of students preferred the flipped-classroom to a traditional lecture. Future studies are needed to determine pedagogical approaches that may improve student's ability to deprescribe.

Conflict of interest

The authors declare no conflict of interest.

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