

RESEARCH ARTICLE

# Quality improvement analysis in a pharmacy skills laboratory course to enhance student pharmacists' education

Lauren M. Caldas<sup>1</sup> , Krista Donohoe<sup>1</sup> , Tyler D. Wagner<sup>1</sup> , Simran K. Rohatgi<sup>2</sup> , Teresa M. Salgado<sup>1</sup> 

<sup>1</sup> Department of Pharmacotherapy & Outcomes Science, Virginia Commonwealth University School of Pharmacy, Virginia, United States

<sup>2</sup> Virginia Commonwealth University School of Pharmacy, Virginia, United States

## Keywords

Education  
Learning outcome  
Pharmacist  
Pharmacy  
Work experience

## Correspondence

Lauren M. Caldas  
Department of Pharmacotherapy &  
Outcomes Science  
Virginia Commonwealth University  
School of Pharmacy  
Virginia  
United States  
[lmcaldas@vcu.edu](mailto:lmcaldas@vcu.edu)

## Abstract

**Background:** When students are admitted to pharmacy school, the intention is for an equitable learning environment. However, students with prior pharmacy work experience may be at an advantage in their pharmacy education compared to those without. **Objective:** To assess the changes made to a skills laboratory course to resolve unintended inequities in course marks between students with and without prior pharmacy work experience. **Methods:** This retrospective, observational, cross-sectional study assessed the impact of previous pharmacy work experience on the outcomes of five class cohorts on scores from: The top 300 exam, pharmacy dispensing activities, and overall marks. Course improvements included team dispensing activities and increasing marked prescriptions from nine to fifteen. Wilcoxon ranked sum test and multivariable logistic regression were used to assess the relationship between prior work experience and course outcomes. **Results:** Over 50% of students in all cohorts had pharmacy work experience. Bivariate analysis showed no significant differences in Top 300 marks or dispensing activity marks between students with and without prior experience, except in Fall 2020. **Conclusion:** Unintended course inequities were addressed through modifications that fostered teamwork among students with diverse work experiences and increased the number of dispensing activities.

## Introduction

After every iteration and throughout the course offering, faculties must reflect on how their courses went (Oermann & Heinrich, 2005). The faculty course reflection should incorporate activities and assessments that went well and those that could be improved, using student feedback from course evaluations, focus groups, and any peer teaching evaluations. The impetus for a faculty course reflection is to ensure that all students' diverse needs are met and that the teaching and assessments foster a fair, equitable environment for student success (Oermann & Heinrich, 2005).

At the Virginia Commonwealth University (VCU) School of Pharmacy, students voiced their perception to the

faculty course coordinator that prior pharmacy work experience was an advantage in the pharmacy skills laboratory course, specifically regarding earning a final letter mark of "A". Pharmacy work experience is not a criterion for admission to the VCU School of Pharmacy; therefore, pharmacy students enter the course with various levels of exposure to pharmacy settings, ranging from none to several years of technician experience.

Previous literature described inconsistent academic and clinical performance in pharmacy school between students with and without prior pharmacy work experience, ranging from limited difference in performance in the first term (Mar *et al.*, n.d.) to no difference (Greene *et al.*, 2010; Bloom *et al.*, 2017) in performances. Other studies have found evidence

describing work experience before pharmacy school as a predictor of knowledge retention (Valdez, 2013). While the literature is inconsistent on the benefits of prior pharmacy experience (Koles *et al.*, 2010; Kiles *et al.*, 2021), many pharmacy schools do not require previous experience for admission (Choi *et al.*, 2023).

With the perceptions of the students in mind, the faculty evaluated the effect of pharmacy work experience on the performance of first-year pharmacy students in a Top 300 medicines exam, marked prescription activities, and the ability to earn an overall A in the skills laboratory course for the Fall of 2018 and Fall of 2019 cohorts (Selznick, 2019). The findings were that work experience was not significantly associated with student performance on the Top 300 exam or the marked prescription activities. However, adjusting for all variables, the prior experience was a significant predictor for the final mark of an A, with students with experience being 36.15 times more likely to have a final mark of A in the course than those without experience (Selznick, 2019). Given these results, the coordinator reflected that this was an unintended inequity and found it important to modify the course to close the performance gap between students with and without pharmacy work experience. Course modifications focused on increasing small-group learning in teams and increasing practice and marked dispensing activities. This study aimed to describe the impact of faculty course modifications in removing the discrepancy in course marks between students with and without pharmacy work experience.

## Methods

This was a retrospective, observational, cross-sectional study assessing the impact of course changes on students' ability to earn an A from five cohorts: the Fall of 2017 and 2018 (n=246), the Fall of 2019 (n=102), the Fall of 2020 (n=96), and the Fall of 2021 (n=94). This first-year pharmacy skills laboratory course at the VCU School of Pharmacy is the first of six sequential longitudinally integrated courses of Foundations of Pharmacy Practice laboratories. This is a 1.5-credit course intended to introduce students to community pharmacy practice, during which students complete prescription dispensing on a rubric scale, a Top 300 medicines exam, various weekly activities related to point-of-care testing, patient counselling, and community pharmacy practice-based skills.

Based on previous findings that students with pharmacy work experience were more likely to obtain an A in the course (Selznick *et al.*, 2019), the course coordinator chose the dispensing activity as the one to

be modified since it accounted for the largest proportion of the grade (30%). The dispensing mark was determined based on a structured rubric of product, label, calculations, and legal documentation (with procedures added for nonsterile compounding dispensing). The first course modification was implemented in the Fall 2019 term. A team of three to four students conducting a dispensing activity was introduced, replacing having students fill prescriptions individually. Teams were designed to support peer-to-peer training by stratifying for students with and without prior pharmacy work experience. Fall 2019 students were marked on eight of their nine prescriptions, similar to the Fall 2017-2018 term; however, three were filled as part of a team, so the course modification balanced personal accountability and support from teammate knowledge. The second course modification was implemented during the Fall 2020 term, which was a combination of virtual and in-person dispensing and included another six prescriptions, thus increasing the course marked "prescriptions" from nine to 15. Further, the Fall 2020 term also included an introduction to nonsterile compounding, where students dispensed four nonsterile compounded products as part of their dispensing grade. The changes made during the Fall of 2020 were maintained during the Fall of 2021 as instruction transitioned back to in-person.

Teams were designed to support peer-to-peer training by stratifying for students with and without prior pharmacy work experience between the assigned laboratory class sections. Students were surveyed during their first lecture for their self-reported years of working in a pharmacy. All enrolled students were then randomly sectioned into classes and given a dispensing team number to divide the class section into teams of three to four students each. All teams had a student or two with no experience, one to two with six months to three years of experience, and at least one student with three or more years of experience.

Only two variables were used, their scheduled laboratory section time and their pharmacy work experience in years. Frequencies and proportions were calculated to summarise categorical variables. Student performance in the course was compared between those with and without prior pharmacy work experience within each cohort. Differences between groups for each assessment were evaluated using a Wilcoxon Ranked Sum test due to the non-parametric nature of the data. Multivariable logistic regression assessed the relationship between students attaining an A in the course and prior work experience while adjusting for type of experience, hours worked per week, years of experience, and the term for the course. Statistical analyses were conducted using SAS, version

9.4. Statistical significance was evaluated with an alpha level set a priori at 0.05.

#### Ethical approval

The Virginia Commonwealth University Institutional Review Board approved the study as exempt. The VCU School of Pharmacy's approval registration number is: HM20011698

## Results

Five cohorts were included in the analysis: the comparator groups from Fall 2017 and 2018 (n=246), the first change in the Fall of 2019 (n=102), the second change in Fall 2020 (n=96), and both changes in Fall 2021 (n=94) (Table I). Most students had prior experience in a pharmacy setting, and over half in community pharmacy (Table I).

**Table I: Cohort demographics and prescription dispensing activities performed**

Parameters	Fall 2017 & Fall 2018 (n=246)	Fall 2019 (n=102)	Fall 2020 (n=96)	Fall 2021 (n=94)
Female gender/pronouns, n (%)	182 (74.0)	73 (71.6)	66 (68.8)	70 (74.5)
Student has previous pharmacy experience ( <u>any</u> ), n (%)	184 (74.8)	75 (73.5)	67 (69.8)	58 (61.7)
Student has previous pharmacy experience ( <u>community specific</u> ), n (%)	168 (68.3)	61 (59.8)	57 (59.4)	52 (55.3)
<b>Years of pharmacy experience, n (%)*</b>				
< 0.5 years	31 (16.9)	7 (9.3)	8 (11.9)	4 (6.9)
0.5-2 years	53 (28.8)	24 (32.0)	27 (40.3)	19 (32.8)
2-5 years	88 (47.8)	34 (45.3)	31 (46.3)	24 (41.4)
> 5 years	12 (6.5)	9 (12.0)	1 (1.5)	6 (10.3)
<b>Hours worked per week, n (%)*</b>				
≤ 20 hours	77 (41.8)	28 (37.3)	27 (40.3)	23 (39.7)
> 20 hours	107 (58.2)	47 (62.7)	40 (59.7)	35 (60.3)
Prescription dispensing activities performed by cohort	One (1) individual marked prescription practice and eight (8) individual marked prescriptions	One (1) individual marked practice prescription, three (3) team-marked prescriptions, and five (5) individual marked prescriptions	Three (3) team practice marked prescriptions, three (3) marked team prescriptions, nine (9) individually marked prescriptions *Mixed virtual and in-person dispensing	Three (3) team practice marked prescriptions, three (3) marked team prescriptions, and nine (9) individual marked prescriptions

\*Denotes denominator corresponding to the number of students with previous pharmacy experience (i.e., n=184 for Fall 2017 & Fall 2018 cohort)

The adjusted logistic regression model showed that prior pharmacy work experience was no longer significantly associated with the likelihood of earning an A after the course changes (Table II). Students who took the course in the Fall of 2021 did not have a

significant advantage over those from the Fall of 2019. Students who took the course in Fall 2020 were almost three times more likely (OR=2.58, 95% CI 1.40-4.78) to earn an A (Table II).

**Table II: Logistic regression model assessing the relationship between final mark of A and prior pharmacy experience, adjusting for type of experience, hours worked per week, years of experience, and class term**

	Adjusted model before course changes <sup>a</sup> (n=246)				Adjusted model after course changes <sup>b</sup> (n=292)			
	Estimate	OR	OR 95% CI	p-value	Estimate	OR	OR 95% CI	p-value
<b>Prior experience (ref=no)</b>								
Yes	1.88	6.55	(1.13, 38.10)	0.0365*	0.75	2.12	(0.35, 12.85)	0.4137
<b>Type of experience (ref=none)</b>								
Community	0.23	1.25	(0.43, 3.63)	0.6777	-0.20	0.82	(0.41, 1.63)	0.5688
All Other	0	§	—	—		§	—	—
<b>Hours worked per week (ref=none)</b>								
≤ 20 hours	0.07	1.08	(0.57, 2.05)	0.8241	0.15	1.16	(0.61, 2.20)	0.6562
> 20 hours	0	§	—	—		§	—	—
<b>Years of experience (ref=none)</b>								
< 0.5 years	-1.67	0.19	(0.04, 0.98)	0.0477*	-0.23	0.80	(0.12, 5.33)	0.8130
0.5-2 years	-1.64	0.20	(0.04, 0.91)	0.0371*	-0.09	0.91	(0.16, 6.54)	0.9159
2-5 years	-1.14	0.32	(0.07, 1.43)	0.1360	0.15	1.16	(0.21, 8.08)	0.8631
> 5 years	0	§	—	—	1.67	5.30	(0.61, 46.42)	0.1321
<b>Term of Skills Laboratory Class (ref=2019)<sup>c</sup></b>								
2020	n/a	n/a	n/a	n/a	0.95	2.58	(1.40, 4.78)	0.0025*
2021	n/a	n/a	n/a	n/a	-0.33	0.72	(0.40, 1.31)	0.2792

CI = Confidence Interval, OR = Odds Ratio; <sup>a</sup> Cohorts (2017-18); <sup>b</sup> Cohorts (2019, 2020, & 2021); <sup>c</sup> Not applicable to cohorts before course changes; § This variable is a linear combination of other variables; therefore, the parameter was set to 0; \* Denotes statistical significance at  $p < 0.05$  level

## Discussion

As part of a quality improvement assessment, the faculty demonstrated that students with prior pharmacy work experience were more liable to earn an A in the skills laboratory course than those without prior pharmacy work experience.

Following two major course changes, the issue was identified and resolved. The course did not become inflated or easier, as indicated by the variable representing the term students were enrolled physically. The analysis revealed a slightly increased likelihood of earning an A during the Fall season of 2020 when the course was taught remotely. However, no such trend was observed in the Fall of 2021, when the course was taught onsite and remained consistent with the implemented changes. The Fall 2021 assessment demonstrated that the modifications were evidence-based and intentionally designed.

First, having a dispensing team was designed based on a team-based learning (TBL) team formation pedagogy as suggested by Burgess and colleagues in 2020. TBL has been utilised and demonstrated benefits within various healthcare and school of pharmacy courses

(Wheeler *et al.*, 2019; Anderson *et al.*, 2021; Carpenter *et al.*, 2022). One crucial element of TBL is the team creation, whereby teams are created to ensure a mix of students with varying levels of background knowledge (Burgess *et al.*, 2020). The dispensing teams were designed to foster background knowledge by stratifying based on community pharmacy experience. TBL guidelines state that these teams should “*stay together as long as possible*” (Parmelee *et al.*, 2012), which was replicated in this skills-laboratory course where the dispensing teams remained unchanged throughout the term. The second course change of the addition of more prescriptions was chosen based on Begley and colleagues' findings, where repeated testing improved learning and performance in a pharmacy skills laboratory course (Begley *et al.*, 2013). Adding six prescriptions allowed formative feedback to increase student learning through low-stakes activities (Gums *et al.*, 2014; Watling & Ginsburg, 2019). Adding to the total number of practice prescriptions demonstrated the testing practice concept is superior for promoting retention (Yang *et al.*, 2019).

In the multivariable regression model, students in the Fall 2020 term were three times more likely to earn an A than in the Fall of 2019. This is consistent with

previously reported inflated scores for the 2020 pandemic virtual terms (Halat et al., 2022), which was resolved when students returned to on-campus learning. A second finding is that students with more than five years of work experience continue to have an advantage in the success of an A in the course over students with no work experience. Individuals with five years of work experience can be classified as experts as defined by the 10,000-hour rule. A person working approximately 40 hours a week, 50 weeks a year for five years has completed approximately 10,000 hours of pharmacy practice. The 10,000-hour rule, coined by Malcolm Gladwell in *Outliers* (Gladwell, 2017), explains these findings that these individuals are experts, and confirms the expectation that they would more likely earn an A in the course. Gladwell surmises cognitively complex activities require practice and more specifically, a significant amount of time (Gladwell, 2013). Pharmacy students with expert-level practical pharmacy exposure will likely continue to do better in the course than those only introduced to concepts that same term.

The final consideration is the argument that not all students must earn an A and that course changes are unnecessary. However, a key aspect is that the course was not designed to be easier for those with prior experience. Identifying this discrepancy allowed the course coordinator to ensure that all students had the potential for success regardless of prior pharmacy work experience.

The Top 300 medicines exam was not influenced by prior work experience. This may be because students are given a list of brands, generic, and pharmacologic categories to study at the beginning of the term. The Top 300 exam is in the revised Bloom's taxonomy category "remember" (or memorise), whereas filling prescriptions would be "apply" (to demonstrate). The higher level of thinking required for applying knowledge may be the reason for the previous inequity in work experience having an effect.

This study has limitations. First, it was performed at a single institution, introducing institutional bias. Second, in cohort studies selection bias and cohort effects are a concern; however, this limitation was minimised by collecting multiple years of data. Notably, collecting data over multiple years resulted in different cohort sizes. This analysis did not account for other confounding factors, only previous academic performances (pre-pharmacy grade point average), and extracurricular pharmacy experiences, and should be explored in future studies. Additionally, the teaching methods changed for the cohorts and should be noted as another limitation. Longitudinal follow-up of students on experiential rotations could be explored to

ensure they successfully utilise their skills in the practice setting.

## Conclusion

To address the inequity identified in a previous study—where students with prior pharmacy work experience were significantly more likely to earn an A in a skills laboratory course—the course coordinator implemented two major quality improvements centred around dispensing. This study expanded upon those findings. Other institutions may wish to evaluate their courses to identify whether unintentional inequities exist and explore effective strategies to address them. In this instance, incorporating team-based learning and increasing the number of exposures successfully resolved an unintended inequity.

## Conflicts of interest

The authors declare no conflict of interest.

## Source of funding

This study did not receive any financial support.

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