A Scoping Review of the Pharmacy Curriculum Outcomes Assessment Literature

Nicholas R. Nelson, PharmD, Sarah M. Anderson, PharmD, Jacqueline M. Zeeman, PharmD, Denise H. Rhoney, PharmD

University of North Carolina at Chapel Hill, UNC Eshelman School of Pharmacy, Chapel Hill, North Carolina

Submitted December 9, 2020; accepted March 18, 2021; published September 2021.

Objective. To identify themes, gaps, and sources of evidence from the literature regarding the Pharmacy Curriculum Outcomes Assessment (PCOA) to inform practice and additional areas for research in pharmacy education.

Findings. Nineteen articles describing the administration and use of PCOA were identified. Since PCOA was made a curricular requirement by the Accreditation Council of Pharmacy Education in 2016, the focus of literature related to the PCOA has shifted from administration practices (four articles published before 2016 vs two articles published since) to determining models that may predict student performance on the assessment (two vs five articles) or how the examination might be used to predict future performance (one vs seven articles), especially on the North American Pharmacist Licensing Examination. While there is a growing body of literature focused on the PCOA’s utility for measuring performance, few variables have been consistently used.

Summary. This review found no studies with objectives that aligned with the initial intended use of the PCOA as defined by the National Association of Boards of Pharmacy, which included tracking individual student performance throughout the curriculum, benchmarking programs against other programs, and evaluating whether a program was meeting their desired outcomes. Additionally, no consensus across the Academy was found as to the proper use of the PCOA, and a paucity of literature exists regarding how the PCOA informs schools and colleges about the effectiveness of their curriculum. There is a need for the Academy to establish a uniform application for the PCOA in pharmacy schools, assess the resources that programs need to administer this required assessment, and determine the utility of the PCOA to measure curricular effectiveness and/or student performance.

Keywords: Pharmacy Curriculum Outcomes Assessment (PCOA), assessment, evaluation, curricular improvement, curriculum effectiveness

INTRODUCTION

The Pharmacy Curriculum Outcomes Assessment (PCOA) is an assessment tool developed by the National Association of Boards of Pharmacy (NABP) as an external measure of student performance in the Doctor of Pharmacy (PharmD) curriculum. First introduced in 2008 as an optional assessment for schools and colleges of pharmacy to administer to students, administration of the PCOA to all students nearing completion of the didactic curriculum became an accreditation requirement in the Accreditation Council for Pharmacy Education (ACPE) Standards 2016. According to the NABP, the PCOA can be used to track individual student performance throughout the curriculum, benchmark programs against other programs, and evaluate whether a program is meeting its desired outcomes. The 2020-2021 PCOA includes 225 items (200 of which contribute to a student’s total score) in five question formats: multiple choice, multiple response, constructed response, ordered response, and hot spot. The assessment spans four content areas and 28 subtopic areas that were determined from a 2015 survey of PharmD outcomes. The content areas are mapped to Appendix 1 of the Center for the Advancement of Pharmacy Education (CAPE) Educational Outcomes. The content areas include the following: Basic Biomedical Sciences (BBS) (10% of the assessment), Pharmaceutical Sciences (PS) (33% of the assessment), Social/Behavioral/ Administrative Sciences (SBAS) (22% of the assessment), and Clinical Sciences (CS) (35% of the assessment).
Multiple studies exploring the PCOA have been published since its inception; however, they are far-ranging and used varied approaches. Despite the information provided from NABP, ACPE, and the published literature, there is ongoing discussion regarding the use, applicability, and administration of the PCOA. Additionally, Mok and Romanelli highlighted the need for further research to advance understanding of the utility of the PCOA related to student core knowledge. The purpose of this scoping review was to identify the extent, range, and quantity of evidence regarding the use of the PCOA and identify potential gaps that could lead to this future research.

METHODS

This scoping review utilized the five-phase procedure outlined by Arksey and O’Malley: identify the research question; identify relevant studies; select relevant articles; chart the data; and collate, summarize, and report the results. A research team of coinvestigators with experience in pharmacy education and scoping reviews was established to conduct and write this review.

This scoping review focused on addressing the question, “What has been published regarding the Pharmacy Curriculum Outcomes Assessment?” This research question was purposefully broad to holistically incorporate the extent, range, and nature of literature regarding the PCOA. The initial search was conducted on November 18, 2019, using PubMed, Embase, and Scopus for literature published since January 2008. The search query identified articles in which the term “Pharmacy Curriculum Outcomes Assessment” or “PCOA” appeared in the title or abstract. Specific pharmacy education journals (eg, American Journal of Pharmaceutical Education, Currents in Pharmacy Teaching and Learning) and references from included articles were searched manually on March 9, 2020, to ensure the thoroughness of the initial search and up-to-date coverage.

After removing duplicates, the articles identified by the search strategy were imported into Covidence (Veritas Health Innovation, Melbourne, Australia). Articles then underwent a two-stage screening process conducted by two of the authors that consisted of title and abstract review and full-text review for inclusion. Letters to the editor, response papers, and conference abstracts were excluded, as well as articles for which the main objective was not evaluating the PCOA. Articles that did not have an abstract but had a title that indicated inclusion were selected for full-text review. All conflicts were resolved independently by the remaining authors.

All of the authors participated in data extraction. Data extraction was documented using a spreadsheet created in Excel that included the following categories: author, year of publication, institution type, sample size, response rate, single or multicenter study, the stakes associated with PCOA and the level of the stakes, predictors used for assessing the PCOA, objective of study/article, methodology of study/analysis, outcomes/results of study/article, remediation program associated with PCOA administration, and other. A category for “other” was included because of the heterogeneity of article types included in the analysis. Once data were charted in the spreadsheet, the authors met to discuss key themes that were identified.

FINDINGS

The database and manual searches yielded 75 articles. Of these, 48 duplicates were eliminated, leaving 27 articles to screen for inclusion in the analysis. Of the 27 articles, four articles were excluded from the analysis because they did not fit the search criteria: one conference abstract, one letter to the editor, one meta-analysis, and one review. Nineteen articles met all of the screening criteria and were ultimately included in the analysis. Four key themes were identified: administration and use of the PCOA, resource investment in the PCOA, student predictors of performance on the PCOA, and the PCOA as a predictor of future performance. Comparing these themes before and after Standards 2016, recent publications have focused primarily on predictors of performance on the PCOA and the PCOA as a predictor of future performance (Figure 1).

Administration and Use of the Pharmacy Curriculum Outcomes Assessment

Since the inception of the PCOA in 2008 and the requirement for using it in 2016, pharmacy schools have been striving to find the best use of the assessment. The common areas that have been reviewed by three major surveys evaluating PCOA administration between 2014-2017 are presented in Table 1. Common areas of interest included: years administered, reasons for administration, utilization of results, stakes associated with the PCOA, who reviewed the results, and remediation plans. These findings indicate that the PCOA was mostly administered in the P3 year and was not considered a high-stakes assessment.

How the PCOA results were used in the assessment plan, who reviewed the PCOA results and when, as well as remediation plans varied across institutions (Table 1).

Two studies used the PCOA examination to highlight gaps in learning: one from a student perspective and the other from a curricular effectiveness perspective through an elective course. In a study that was conducted prior to the PCOA administration requirement, Naughton and
Friesner sought to determine whether a correlation existed between third-year students’ perceived knowledge and actual knowledge assessed by the PCOA. This study found that Basic Biomedical Sciences (BBS) was the only content area where there was a significant correlation between actual and perceived student knowledge. In the other domains, students overestimated their knowledge, leading the investigators to suggest that having a standardized measure to assess curricular effectiveness aside from only student perception data might be beneficial. Burris and colleagues, however, assessed the impact of an elective journal club course on longitudinal curriculum performance using PCOA performance along with grades in other key Clinical Sciences (CS) courses and acute/ambulatory care APPEs. The overall scaled PCOA scores of students who participated in the elective were on average 24.5 points higher and clinical science section scaled scores were 28.2 points higher than the scores of their peers who had not completed the elective.

**Resources Invested in Administering the Pharmacy Curriculum Outcomes Assessment.**

Only one study explored the financial and faculty resources used to prepare students for taking the PCOA examination. This study also surveyed programs about their investment in preparing students to take the North American Pharmacist Licensure Examination (NAPLEX) and compared how the investments made to prepare students for both examinations compared to NAPLEX pass rates. A total of 91% of US schools and colleges of pharmacy responded to the survey. Only 20% (n=18) of the schools provided PCOA preparation to their students compared to 79% (n=72) that provided NAPLEX review. The type of review programs for the PCOA ranged from live review sessions conducted by faculty (n=5) to question banks developed by a vendor (n=4) or internally developed question banks (n=3) for students to study independently. The majority of respondents (n=9) did not spend extra monetary dollars on their programs while five schools and colleges spent $1-$4,999 and one spent $30,000-$34,999. The vast majority of schools that provided PCOA preparation were legacy schools founded prior to 1995 (n=12 of the 18) with an even distribution between public (n=10) and private (n=8) programs. Notably, programs that did not provide PCOA preparation cited an interest in gaining insight in estimates of student knowledge as a reason for not providing PCOA preparation.

**Predictors of Pharmacy Curriculum Outcomes Assessment Performance**

Seven of the 19 articles included in this analyses evaluated whether various demographics, admissions, and academic factors were predictors of student performance on the PCOA. Each of these studies was conducted at a single institution. Four of the seven articles assessed curricula where the PCOA was administered only during the third professional year, while another article reviewed the PCOA performance of 142 students who took the PCOA in their second professional year. Two studies evaluated students’ performance on the PCOA when administered over the first, second, and third professional...
| Author and Year of Survey Administration | Public/Private Response Rate, n (%) | Year(s) of PCOA Administration, n (%) | Reasons for Administration, n (%) | Utilization of Results in Assessment Plan, n (%) | Reviewer Prior to Student Distribution, n (%) | Remediation Plans, n (%) |
|------------------------------------------|------------------------------------|--------------------------------------|-----------------------------------|-----------------------------------------------|-----------------------------------------------|-------------------------|
| Gortney* 2014                            | 41/52 (79)                         | P1: 10 (26)                          | Programmatic assessment: 29 (76)  | None: 23 (61)                                 | Administrator*: 32 (84)                       | Not in use: 25 (66)            |
|                                          | 22 (54)/19 (46)                   | P2: 11 (29)                          | Benchmarking: 28 (74)             | Low: 10 (26)                                  | Committee*: 16 (38)                         | Required when threshold not met: 4 (11) |
|                                          |                                    | P3: 35 (92)                          | ACPE National Assessment: 25 (66) | Medium: 3 (8)                                 | Faculty advisors: 8 (21)                     | Other: 4 (11)               |
|                                          |                                    | P4: 3 (8)                            | Individual feedback: 25 (66)      | High: 1 (3)                                   | Department chair: 1 (3)                     |                         |
|                                          |                                    |                                      | Feasibility: 22 (58)              |                                               |                                               |                         |
|                                          |                                    |                                      | Programmatic assessment:          |                                               |                                               |                         |
|                                          |                                    |                                      | examination: 13 (34)              |                                               |                                               |                         |
|                                          |                                    |                                      | Internal assessment               |                                               |                                               |                         |
|                                          |                                    |                                      | alternate years in curriculum:    |                                               |                                               |                         |
|                                          |                                    |                                      | 8 (21)                            |                                               |                                               |                         |
|                                          |                                    |                                      | Combination of PCOA and clinical  |                                               |                                               |                         |
|                                          |                                    |                                      | skills-based assessment:          |                                               |                                               |                         |
|                                          |                                    |                                      | 11 (29)                           |                                               |                                               |                         |
| Gortney** 2016                           | 92/135 (68)*                       | P1: 13 (14)                          | Curricular assessment: 70 (76)    | None/Low: P1: NR (50)                         | At risk identified by: Committee*: 9 (45)    | Poor performers required remediation: NR (25) |
|                                          |                                    | P2: 15 (16)                          | Individual student performance    | P2: NR (47)                                   | Dean or director of assessment: 7 (35)       | P3: 20 (24)               |
|                                          |                                    | P3: 85 (92)                          | assessment: 68 (74)               | P3: NR (75)                                   | Remediation identified by: Faculty committee: 5 (25) |
|                                          |                                    | P4: 5 (5)                            | Cohort performance assessment:    | P3: NR (50)                                   | Dean or director of assessment: 11 (55)      | P1: 6 (54)                |
|                                          |                                    |                                      | 65 (71)                           |                                               |                                               |                         |
|                                          |                                    |                                      | Student progress assessment:      |                                               |                                               |                         |
|                                          |                                    |                                      | 18 (20)                           |                                               |                                               |                         |
|                                          |                                    |                                      | Other: 14 (15)                    |                                               |                                               |                         |
|                                          |                                    |                                      | NA                                |                                               |                                               |                         |
|                                          |                                    |                                      | NA                                |                                               |                                               |                         |
|                                          |                                    |                                      | NA                                |                                               |                                               |                         |
|                                          |                                    |                                      | NA                                |                                               |                                               |                         |
| Sweet** 2017                             | 126/139 (91)*                      | P3 only prior to Standards 2016: 29  | Identify at-risk students: 37 (29)| Provided individual scores to students: 122 (97)| Poor performers required to meet with advisor/administrator: 37 (29)|                         |
|                                          |                                      | (52)                                 | Note: Only 56 programs administered PCOA prior to the 2016 requirement | Provided class/cohorts scores to students: 76 (60) | All students required to meet with advisor: 14 (11) |                         |
|                                          |                                      |                                      | NA                                | Changes to didactic curriculum: 35 (81)       | Remediation: 15 (35)                         |                         |
|                                          |                                      |                                      | NA                                |                                               | Student progression: 9 (21)                   |                         |

**Abbreviations:** P1 = first professional year, P2 = second professional year, P3 = third professional year, P4 = fourth professional year, ACPE = Accreditation Council for Pharmacy Education, NA = not applicable, NR = not reported.

*Dean, associate dean, assistant dean.

**Progressions or assessment.

*Did not report public vs private institutions.
years. Additionally, three studies assessed predictors of student performance on PCOA content areas as well as total scaled score.\textsuperscript{15,17} 

Five articles evaluated pre-pharmacy factors to predict student performance on the PCOA (Table 2).\textsuperscript{16-20} All five studies included cumulative pre-pharmacy grade point average (GPA) as a predictor of PCOA total scaled score performance; however, only Hein and colleagues and Medina and colleagues similarly found significantly positive correlations between the two. Pre-pharmacy science GPA was found to be a positive predictor of a student’s PCOA total scaled score in the three studies that assessed it, although this trend did not continue for all four PCOA content areas.\textsuperscript{18-20} All five studies also assessed Pharmacy College Admission Test (PCAT) performance as a predictor of PCOA performance; however, Giuliano and colleagues only reported PCAT sub-score results. Medina and colleagues determined that the inclusion of three PCAT sub-scores (Verbal, Biology, Chemistry) collectively explained more variance than the PCAT composite score alone, and thus the authors did not include PCAT composite scores in their models.\textsuperscript{20} 

Table 2. Admission Criteria as Predictors of Pharmacy Curriculum Outcomes Assessment (PCOA) Performance

| PCOA Area | Reference (n)/Professional Year | Male Gender | Undergraduate GPA | PCAT |
|-----------|---------------------------------|-------------|-------------------|------|
| PS        | Hein\textsuperscript{18} (384)/P3 | NA          | NA                | NA   |
|           | McDonough\textsuperscript{19} (159)/P3 | 0.47        | NS                | 0.389|
|           | Medina\textsuperscript{20} (179)/P3 | 0.14        | NA                | NA   |
| SBAS      | Hein\textsuperscript{18} (384)/P3 | NA          | NA                | NA   |
|           | McDonough\textsuperscript{19} (159)/P3 | 0.47        | NS                | 0.17 |
|           | Medina\textsuperscript{20} (179)/P3 | 0.14        | NA                | NA   |
| CS        | Hein\textsuperscript{18} (384)/P3 | NA          | NA                | NA   |
|           | McDonough\textsuperscript{19} (159)/P3 | 0.47        | NS                | 0.17 |
|           | Medina\textsuperscript{20} (179)/P3 | 0.14        | NA                | NA   |

**Abbreviations:** GPA=grade point average, PCAT=Pharmacy College Admissions Test, P1=first professional year, P2=second professional year, P3=third professional year, NA=not applicable, NS=not significant, BBS=Basic Biomedical Sciences, PS=Pharmaceutical Sciences, SBAS=Social/Behavioral/Administrative Sciences, CS=Clinical Sciences, all p <.05
PCOA performance for students who completed prerequisites at a different institution than their pharmacy school compared to those who completed prerequisites at the same university as their pharmacy school.16

Seven studies evaluated academic factors for any association with students’ performance on the PCOA (Table 3). All studies found significant positive correlations between cumulative pre-PCOA grade point average (GPA) and PCOA total scaled scores, although of varying degrees.15–21 Hein and colleagues found that students’ pre-PCOA GPA accounted for the most variance in their model (26% of 60% of total variance predicted by the model).18 Interestingly, Scott and colleagues evaluated P3 PCOA scores over three years, finding the correlation strength of pre-PCOA GPA decreased as students progressed through the curriculum.15 Garavalia and colleagues assessed GPA on all required courses within the PharmD program as the only academic factor associated with PCOA and determined it to have a large effect size.21 Only two studies assessed student remediation as a predictor of PCOA performance; however, the studies yielded somewhat conflicting results.19,20 In a post hoc analysis, McDonough and colleagues found a negative relationship with PCOA performance for students who had a history of poor academic performance but had not repeated any academic content compared to students with no academic performance issues. Students with a history of poor academic performance who had repeated academic content, however, performed no differently than those who had no academic issues.19 Conversely, Medina and colleagues found that remediation of any course was negatively correlated with PCOA total scaled score.20 The article by Giuliano and colleagues was the only one that noted a remediation plan associated with student PCOA performance, where students who scored greater than or equal to two standard deviations below the institution’s average must undergo a remediation plan with a faculty advisor.16 Medina and colleagues also evaluated an institution specific curricular element in their study, finding that taking a PCOA Prep test the semester before the official PCOA was administered had a significant positive correlation with students’ PCOA total scaled score as well as with each content area score ($R^2 = 0.09, 0.2, 0.41, 0.17, 0.28$, respectively), with this difference explaining the most unique variance in their model (9% of 61%).20

Pharmacy Curriculum Outcomes Assessment as a Predictor of Future Performance

A study by Nyman and colleagues evaluated the ability of 23 different predictive covariates, including PCOA score, to measure advanced pharmacy practice experience (APPE) readiness in 226 graduating students from the years 2015-2018.22 Advanced Pharmacy Practice Experience readiness was defined as midpoint core APPE scores, which they applied in three different statistical models. In all three models, PCOA total scaled score was a significant predictor of APPE scores and readiness. In the authors’ All Core APPE Rotation Model, PCOA total scaled score, pre-APPE GPA, and student age were the strongest predictors ($R^2 = 0.16$). In the Acute and Ambulatory Care Model, the only predictor was PCOA total scaled score ($R^2 = 0.07$). In the Number of Midpoint Core Clerkship Failing Scores Model, the strongest predictors were PCOA total scaled score, age, final GPA in therapeutic course sequence, and problems in pharmacotherapy final grade.22 Additionally, Hein and colleagues concluded that PCOA PS and CS content areas were also useful for students to leverage APPEs to fill gaps in content and application knowledge.18

Seven studies evaluated PCOA as a predictor of pharmacy graduate performance on licensing examinations, with five studies evaluating the NAPLEX18,21,23–26 and one evaluating the Multistate Pharmacy Jurisprudence Examination (MPJE).27 Five studies were conducted at single institutions and yielded similar results, finding that the PCOA total scaled scores of third professional year (P3) students were positively correlated with their NAPLEX scores (Table 4).18,21,23–25 Specifically, Naughton and Friesner evaluated 108 P3 students who took the PCOA during the 2009–2010 academic year and found that PCOA total scaled score and content area scaled scores were significantly correlated with all NAPLEX scores, including total NAPLEX and three NAPLEX competency area scores, except PCOA SBAS scores and NAPLEX Competency Area 2: Assess Safe and Accurate Methods to Prepare and Dispense Medications.23 Similarly, Shah and colleagues and Hein and colleagues evaluated 433 P3 PCOA test takers from 2012-2016 and 384 P3 PCOA test takers from 2012-2015, respectively, and their subsequent NAPLEX scores.18,24 Hein and colleagues found that PCOA total scaled score and all subtopic domain scaled scores were positively correlated with NAPLEX overall scores.18,24 Furthermore, Shah and colleagues determined that P3 students’ PCOA scaled scores of less than 349 were found to be one of the independent factors associated with a poor NAPLEX outcome, defined as a NAPLEX overall score ≤ 82.23 Similarly, Welch and Karpen found PCOA to be a significant predictor of both NAPLEX scores and NAPLEX pass rates.25 Garavalia and colleagues found that PCOA scores accounted for 8% of variance on NAPLEX scores, although GPA explained 14% of NAPLEX score variance.21
| PCOA Area | Reference / Professional Year PCOA Administered (n) | Pre-PCOA GPA | Course remediation |
|-----------|------------------------------------------------------|--------------|-------------------|
| Total     | Scott et al.\textsuperscript{15} / P1 (NR)          | 2008: 0.4    | NA                |
|           |                                                      | 2009: NS     | NA                |
|           |                                                      | 2010: NS     | NA                |
|           |                                                      | 2008: 0.32   | NA                |
|           |                                                      | 2009: NS     | NA                |
|           |                                                      | 2010: 0.15   | NA                |
|           |                                                      | 2008: 0.71   | NA                |
|           |                                                      | 2009: 0.46   | NA                |
|           |                                                      | 2010: 0.26   | NA                |
|           | Giuliano et al.\textsuperscript{16} / P2 (142)     | 26.597 a     | NA                |
|           | Garavalia et al.\textsuperscript{21} / P3 (271)    | 0.47         | NA                |
|           | Gillette et al.\textsuperscript{17} / P1 (293)     | 0.218        | NA                |
|           |                                                      | 0.299        | NA                |
|           |                                                      | 0.439        | NA                |
|           | Hein et al.\textsuperscript{18} / P3 (384)         | 0.6          | NA                |
|           | McDonough et al.\textsuperscript{19} / P3 (159)    | 0.5          | No need: Progressed b- significant, NR |
|           |                                                      | No Need: Remediated c - NS |
|           |                                                      | Progressed: Remediated d - NS |
|           | Medina et al.\textsuperscript{20} / P3 (179)       | 0.57         | -0.19             |
| BBS       | Hein et al.\textsuperscript{18} / P3 (384)         | 0.47         | NA                |
|           | McDonough et al.\textsuperscript{19} / P3 (159)    | 0.19         | No need: Progressed b- NS |
|           |                                                      | No Need: Remediated c - NS |
|           |                                                      | Progressed: Remediated d - NS |
|           | Medina et al.\textsuperscript{20} / P3 (179)       | 0.14         | 0.1               |
| PS        | Hein et al.\textsuperscript{18} / P3 (384)         | 0.51         | NA                |
|           | McDonough et al.\textsuperscript{19} / P3 (159)    | 0.42         | No need: Progressed b- significant, NR |
|           |                                                      | No Need: Remediated c - NS |
|           |                                                      | Progressed: Remediated d - NS |
|           | Medina et al.\textsuperscript{20} / P3 (179)       | NS           | NS                |
| SBAS      | Hein et al.\textsuperscript{18} / P3 (384)         | 0.31         | NA                |
|           | McDonough et al.\textsuperscript{19} / P3 (159)    | 0.24         | No need: Progressed b- NS |
|           |                                                      | No Need: Remediated c - NS |
|           |                                                      | Progressed: Remediated d - NS |
|           | Medina et al.\textsuperscript{20} / P3 (179)       | 0.1          | NS                |
| CS        | Hein et al.\textsuperscript{18} / P3 (384)         | 0.53         | NA                |
|           | McDonough et al.\textsuperscript{19} / P3 (159)    | 0.56         | No need: Progressed b- significant, NR |
|           |                                                      | No Need: Remediated c - NS |
|           |                                                      | Progressed: Remediated d - NS |
|           | Medina et al.\textsuperscript{20} / P3 (179)       | 0.1          | NS                |

\textsuperscript{a}Unstandardized Beta coefficient
\textsuperscript{b}No need for remediation vs. Need for remediation but progressed without remediation
\textsuperscript{c}No need for remediation vs. Need for remediation and remediated
\textsuperscript{d}Need for remediation but progressed without remediation vs Need for remediation and remediated

**Abbreviations:** GPA = grade point average, NR = not reported, P1 = first professional year, P2 = second professional year, P3 = third professional year, NA = not applicable, NS = not significant, BBS = Basic Biomedical Sciences, PS = Pharmaceutical Sciences, SBAS = Social/Behavioral/Administrative Sciences, CS = Clinical Sciences, all \( p < .05 \)
The positive correlation between PCOA and NAPLEX scores at these single institutions was also observed in one multi-institution study evaluating 1,454 P3 PCOA test takers in 2012-2014 and their subsequent NAPLEX scores at six pharmacy schools. The PCOA total scaled scores and NAPLEX overall scores were significantly correlated as were PCOA total and content area scaled scores and NAPLEX overall and competency area scores. Linear regression models estimated a 1.0-point increase in PCOA total score was associated with a 0.15-point increase in the overall NAPLEX score when controlling for other factors.26

In addition to evaluating the utility of the PCOA to predict NAPLEX scores, one study evaluated the relationship between the PCOA and the Multistate Pharmacy Jurisprudence Examination (MPJE). In this single center study evaluating the North Carolina MPJE, Mospan and colleagues sought to determine an association between PCOA total and content area scaled scores in addition to several admissions and curriculum variables and MPJE scores (Table 4).27

**DISCUSSION**

The volume of literature regarding the PCOA has increased since it was made an accreditation requirement by ACPE in 2016. Further, the themes of these publications have shifted (Figure 1). Most publications prior to the accreditation requirement focused on how schools and colleges of pharmacy were administering the assessment and whether faculty could predict student PCOA performance. Since its requirement, however, more attention has been paid to predicting student performance on the PCOA and using the PCOA as a way to predict future student performance, particularly on licensure examinations. Although not an intended use of the examination,1 PCOA performance has been commonly used to predict North American Pharmacist Licensure Examination (NAPLEX) scores and pass rates, despite that the blueprints for these examinations are different.6,26 Additionally, if the primary use of the PCOA is to predict future success on the NAPLEX, it might be more beneficial to administer the NAPLEX to students prior to graduation instead of creating another examination given the different blueprints for the assessments.

A follow-up survey to gain insight into the resources required to conduct the PCOA and how pharmacy schools are utilizing the results may be helpful to investigate the cost effectiveness of administering the assessment, especially given that the number of programs administering the PCOA has nearly tripled since the first survey.28 A clear use for the examination that is broadly accepted among the Academy, whether that is the initial intent of student tracking, program benchmarking, and curriculum outcome evaluation, or the recently described use as a predictor of future success, should be established first to justify the resources devoted to administering the assessment. If the latter is true, however, the Academy and NABP should critically evaluate whether the PCOA is the appropriate assessment for that purpose considering the differences in blueprints between PCOA and the licensure examinations (ie, NAPLEX, MPJE).

Similarities were found among the studies that evaluated various admission and curriculum predictors of PCOA performance. The PCAT Composite score and undergraduate science GPA were positive predictors in all studies that evaluated these variables, while sex seemed to be a nonsignificant predictor. However, not all studies evaluated a common set of admissions variables and several institution-specific variables were included in the respective studies, making direct comparison difficult. In their investigation of pre-PCOA GPA, Daugherty and Malcom confirmed a correlation between P3 GPA and PCOA performance, although a high degree of heterogeneity was seen in most models.29 However, the use of GPA as a predictor poses some potential challenges. First, using pre-PCOA GPA does not allow much time to work with at-risk students given that students take the examination anywhere from one to five months after this GPA is calculated. Furthermore, there has been movement within the Academy toward competency-based education with the implementation of entrustable professional activities.30 As more schools consider and adopt competency-based curricula, traditional GPA may no longer be able to be calculated, limiting the utility of GPA to predict PCOA performance and identify students who may be at risk.

Course remediation may be a more applicable variable for predicting PCOA performance and identifying at-risk students, but has shown mixed results, possibly because of inconsistencies in how remediation is defined across the Academy. Of note, McDonough and colleagues found that students who met remediation criteria but did not repeat the course scored significantly lower on the PCOA total scaled score as well as the PS and CS content areas.19 This could be because of the greater focus of the PCOA on these areas (33% and 35%, respectively). While the specific course or course content was not described,
identification of students struggling with this content during the course and early remediation could improve student PCOA scores. Additionally, multiple studies reported a correlation between PCOA total scaled score and NAPLEX score, which was also found by Daugherty and Malcom in their meta-analysis, indicating course remediation may improve NAPLEX scores.29

There are some limitations to this review. First, this review may have missed some relevant studies. To minimize this risk, multiple databases were searched as well as specific American pharmacy education journals. Another notable limitation to this review is lack of critical appraisal of the included articles. However, the purpose of this scoping review was to summarize the current literature and not evaluate the quality of the data. This approach allowed for a greater range of studies and methodologies to be included and gaps to be identified from possibly low-quality research. This was especially important given that the PCOA has been an accreditation requirement for less than five years, and a myriad of study designs and objectives may have been used in the research studies reported on in the literature.

This scoping review identified few uses of PCOA that are in line with NABP’s initial intent for the examination, including tracking individual student performance throughout the curriculum, benchmarking programs against other programs, and evaluating whether a program is meeting the school’s desired outcomes. The majority of pharmacy schools do not administer the assessment over multiple years and therefore are not able to track individual student performance throughout the curriculum. Further, only one study discussed comparing PCOA performance at different schools and colleges of pharmacy, and that study was published six years before the PCOA requirement was implemented in 2016.15 Only one included study described how a program can use the PCOA to evaluate their desired outcomes,13 although 76% of respondents noted using PCOA for curricular assessment.10 Medina and colleagues, however, proposed that the intent of the PCOA may be to assess students’ readiness for APPEs rather than curricular effectiveness.20 This perspective complements findings from the study by Nyman and colleagues showing PCOA score was a modest but consistent predictor of APPE performance.22 Nevertheless, because PCOA is a knowledge-based examination, caution should be used in using it as the sole assessment of APPE readiness. Advanced pharmacy practice experiences should prepare students for pharmacy practice, which requires developing academic and non-academic competencies, including knowledge and skills; however, the PCOA only measures knowledge. Therefore, Nyman and colleagues’ findings might indicate that suboptimal assessments of students’ readiness for and performance during APPEs are being used given that knowledge is such a heavy predictor of student APPE performance and other critical skills are not adequately assessed during APPE student evaluations.

| Reference / Professional Year | PCOA Administered (n) | Total | BBS | PS | SBAS | CS |
|------------------------------|-----------------------|-------|-----|----|------|----|
| NAPLEX Total                 | Naughton and Friesner23 / P3 (108) | 0.59  | 0.448 | 0.57 | 0.338 | 0.571 |
| Garavalia et al.21 / P3 (271) | 0.51 | NA | NA | NA | NA | NA |
| Welch and Karpen25 / P3 (201) | 0.13a | NA | NA | NA | NA | NA |
| Hein et al.18 / P3 (384)     | 0.64 | 0.42 | 0.59 | 0.32 | 0.58 |
| Rudolph et al.26 / P3 (1454) | 0.54 | 0.37 | 0.51 | 0.32 | 0.5 |
| NAPLEX Area 1                | Naughton and Friesner23 / P3 (108) | 0.583 | 0.431 | 0.532 | 0.363 | 0.584 |
| Rudolph et al.26 / P3 (1460) | 0.47 | 0.34 | 0.44 | 0.25 | 0.44 |
| NAPLEX Area 2                | Naughton and Friesner23 / P3 (108) | 0.351 | 0.25 | 0.399 | NS | 0.322 |
| Rudolph et al.26 / P3 (1460) | 0.46 | 0.27 | 0.45 | 0.33 | 0.39 |
| NAPLEX Area 3                | Naughton and Friesner23 / P3 (108) | 0.464 | 0.446 | 0.419 | 0.298 | 0.397 |
| Rudolph et al.26 / P3 (1460) | 0.34 | 0.22 | 0.29 | 0.22 | 0.33 |
| NAPLEX Pass Rate             | Welch and Karpen25 / P3 (201) | 0.028a | NA | NA | NA | NA |
| NC MPJE                      | Mospan et al.27 / NR (85) | 0.28 | NS | NS | NS | 0.28 |

*aBeta coefficient

Abbreviations: P3=Third Professional Year, BBS=Basic Biomedical Sciences, PS=Pharmaceutical Sciences, SBAS=Social/Behavioral/Administrative Sciences, CS=Clinical Sciences, NAPLEX=North American Pharmacist Licensure Examination, NA=not applicable, NS=not significant, NC MPJE=North Carolina Multistate Pharmacy Jurisprudence Examination, NR=not reported, all p<.05
CONCLUSION

Based on the published literature regarding the Pharmacy Curriculum Outcomes Assessment, there seems to continue to be inconsistencies in how schools and colleges of pharmacy are using the examination. Furthermore, these uses do not seem to be in line with the initial intent of the PCOAs set forth by the NABP. If a main purpose of administering the PCOA is to give pharmacy programs insight into the effectiveness of their curriculum, more studies like that conducted by Burris and colleagues are warranted to investigate this use of the assessment. Additionally, future studies on the use of the PCOA to identify areas for curricular improvement are needed to shed light on the value and utility of the assessment. This study in addition to a new study on the resources, both financial and human, required to administer the PCOA are needed to better understand the investment pharmacy programs make related to this assessment and the PCOA’s utility to measure curricular effectiveness.

REFERENCES

1. National Association of Boards of Pharmacy. PCOA. Accessed March 2, 2021. https://nabp.pharmacy/programs/pcoa/
2. Accreditation Council for Pharmacy Education. Accreditation Standards and Key Elements for the Professional Program in Pharmacy Leading to the Doctor of Pharmacy Degree. Published 2015. Accessed March 2, 2021. https://www.acpe-accredit.org/pdf/Standards2016FINAL.pdf
3. National Association of Boards of Pharmacy. Sample items of the pharmacy curriculum outcomes assessment (PCOA). Published 2016. Accessed March 2, 2021. https://nabp.pharmacy/wp-content/uploads/2016/07/PB-PCOA-Sample-Items.pdf
4. National Association of Boards of Pharmacy. The 2015 United States Schools and Colleges of Pharmacy Curriculum Survey – Summary Report. 2016. https://nabp.pharmacy/wp-content/uploads/2016/09/2015-PCOA statt- and-pcoa-curricular-survey.pdf
5. Medina M, Plaza C, Stowe C, et al. Center for the Advancement of Pharmacy Education 2013 educational outcomes. Am J Pharm Educ. 2013;77(8):162.
6. National Association of Boards of Pharmacy. Content Areas of the Pharmacy Curriculum Outcomes Assessment (PCOA). Published 2016. Accessed March 2, 2021. https://nabp.pharmacy/wp-content/uploads/2016/07/PB-PCOA-Content-Areas-2016.pdf
7. Mok TY, Romanelli F. Identifying best practices for and utilities of the pharmacy curriculum outcomes assessment examination. Am J Pharm Educ. 2016;80(10):163. doi:https://doi.org/10.5688/ajpe8010163
8. Arksey H, O’Malley L. Scoping studies: towards a methodological framework. Int J Soc Res Methodol Theory Pract. 2005;8(1):19–32. doi:https://doi.org/10.1080/1364557032000119616
9. Gortney JS, Brasy BS, Salinirni FD. Implementation and use of the pharmacy curriculum outcomes assessment at US schools of pharmacy. Am J Pharm Educ. 2015;79(9):137. doi:https://doi.org/10.5688/ajpe799137
10. Gortney JS, Rudolph MJ, Augustine JM, et al. National trends in the adoption of PCOA for student assessment and remediation. Am J Pharm Educ. 2019;83(6):6796. doi:https://doi.org/10.5688/ajpe6796
11. Sweet BV, Assemi M, Boyce E, et al. Characterization of use of the pharmacy curriculum outcomes assessment across accredited colleges of pharmacy. Am J Pharm Educ. 2019;83(7):7091. doi:https://doi.org/10.5688/ajpe7091
12. Naughton CA, Friesner DL. Comparison of pharmacy students’ perceived and actual knowledge using the pharmacy curriculum outcomes assessment. Am J Pharm Educ. 2012;76(4):63. doi:https://doi.org/10.5688/ajpe76463
13. Burris JN, Frederick JK, Malcom DR, et al. Impact of a journal club elective course on student learning measures. Am J Pharm Educ. 2019;83(7):6827.
14. Lebovitz L, Shuford VP, DiVall MV, et al. Creating an arms race? Examining school costs and motivations for providing NAPLEX and PCOA preparation. Am J Pharm Educ. 2017;81(7):5909. doi:https://doi.org/10.5688/ajpe8175909
15. Scott DM, Bennett LL, Ferrill MJ, et al. Pharmacy Curriculum Outcomes Assessment for individual student assessment and curricular evaluation. Am J Pharm Educ. 2010;74(10):183. doi:https://doi.org/10.5688/ajpe7410183
16. Giuliano CA, Gortney J, Binienda J. Predictors of performance on the pharmacy curriculum outcomes assessment (PCOA). Curr Pharm Teach Learn. 2016;8(2):148–154. doi:https://doi.org/10.1016/j.cptl.2015.09.011
17. Gillette C, Rudolph M, Rockich-Winston N, et al. Predictors of student performance on the Pharmacy Curriculum Outcomes Assessment at a new school of pharmacy using admissions and demographic data. Curr Pharm Teach Learn. 2017;9:84–89. doi:https://doi.org/10.1016/j.cptl.2016.08.033
18. Hein B, Messinger NJ, Penn J, et al. Correlation of the pharmacy curriculum outcomes assessment and selected pre-pharmacy and pharmacy performance variables. Am J Pharm Educ. 2019;83(3):342–346. doi:10.5688/ajpe6579
19. McDonough SL, Spivey CA, Chisholm-Burns MA, et al. Examination of factors relating to student performance on the pharmacy curriculum outcomes assessment. Am J Pharm Educ. 2019;83(2):205–211. doi:10.5688/ajpe6516
20. Medina MS, Neely S, Draugalis JLR. Predicting pharmacy curriculum outcomes assessment performance using admissions, curricular, demographics, and preparation data. Am J Pharm Educ. 2019;83(10):7526. doi:https://doi.org/10.5688/ajpe7526
21. Garavalia LS, Prabhu S, Chung E, et al. An analysis of the use of Pharmacy Curriculum Outcomes Assessment (PCOA) scores within one professional program. Curr Pharm Teach Learn. 2017;9(2):178–184. doi:https://doi.org/10.1016/j.cptl.2016.11.008
22. Nyman H, Moorman K, Tak C, et al. Advanced pharmacy practice experiences - a modeling exercise to identify predictors of student readiness. Am J Pharm Educ. 2020;84(5):7783. doi:https://doi.org/10.5688/ajpe7783
23. Naughton CA, Friesner DL. Correlation of P3 PCOA scores with future NAPLEX scores. Curr Pharm Teach Learn. 2014;6(6):877–883. doi:https://doi.org/10.1016/j.cptl.2014.07.017
24. Shah S, Peng I, Seifert CF. A model to predict NAPLEX outcomes and identify students needing additional preparation. Curr Pharm Teach Learn. 2019;11(8):810–817. doi:https://doi.org/10.1016/j.cptl.2019.04.009
25. Welch AC, Karpen SC. Comparing student performance on the old vs new versions of the NAPLEX. Am J Pharm Educ. 2018;82(3):6408. doi:https://doi.org/10.5688/ajpe6408
26. Rudolph MJ, Gortney JS, Maerten-Rivera JL, et al. A study of the relationship between the PCOA and NAPLEX using a
multi-institutional sample. *Am J Pharm Educ.* 2019;83(2):6867. doi:https://doi.org/10.5688/ajpe6867

27. Mospan G, Gillette C, Mospan CM. Predictors of performance on the North Carolina Multistate Pharmacy Jurisprudence Examination. *Curr Pharm Teach Learn.* 2020;12(1):35–40. doi:https://doi.org/10.1016/j.cptl.2019.10.004

28. American Association of Colleges of Pharmacy. Academic Pharmacy’s Vital Statistics. Published 2020. Accessed March 2, 2021. https://www.aacp.org/article/academic-pharmacys-vital-statistics#

29. Daugherty KK, Malcom DR. Assessing the relationship among PCOA performance, didactic academic performance, and NAPLEX scores. *Am J Pharm Educ.* 2020;84(8):847712. doi:10.5688/ajpe847712

30. Pittenger AL, Chapman SA, Frail CK, et al. Entrustable professional activities for pharmacy practice. *Am J Pharm Educ.* 2016;80(4):57. doi:https://doi.org/10.5688/ajpe80457