

Correlating Students' Metacognitive Monitoring with Performance on Calculations concepts

Bernadette D'Souza, Ph.D.; Georges Adunlin, Ph.D., MA, MSEd.

Department of Pharmaceutical, Social and Administrative Sciences, McWhorter School of Pharmacy,
Samford University, Birmingham, AL 35229

Background

- A fundamental skill of a pharmacist is to accurately and repeatedly perform pharmaceutical calculations in order to prevent medication errors.¹
- The importance of performing pharmaceutical calculations is highlighted in Sub-domain 1.1 (scientific thinking) of the AACP Curriculum Outcomes and Entrustable Professional Activities (COEPA) 2022.²
- The North American Pharmacist Licensure Examination (NAPLEX) blueprint indicates that Area 4 - Perform Calculations, occupies approximately 14% of the examination.³
- A variety of teaching methodologies has been used for teaching pharmaceutical calculations, including differentiated instruction, lecture-based instruction, technology-based learning, group learning, individual learning, inquiry-based learning, kinesthetic learning, game-based learning and expeditionary learning.¹
- The science of teaching and learning has shown that metacognition is important for learning to be successful.⁴
- Thus, it is vital to guide students towards understanding, monitoring, and adjusting their study strategies to achieve success in pharmaceutical calculations courses.

Objectives

- To use exam wrappers as a way of allowing students to reflect on their study habits and learning strategies.
- To evaluate students' retention of math concepts and metacognition three months after completion of a pharmacy calculations course.

Materials and Methods

Participants and Setting

- First year professional pharmacy students (N=86) enrolled in a two credit hours Pharmaceutical Calculation course in the Fall semester.

Project Design and Implementation Plan

- The learning management system (Canvas LMS) was used to build various learning activities including pre-lecture videos, weekly formative content quizzes, student-led review sessions, and formative assessments via the testing platform (ExamSoft) as a way of providing a toolkit of effective learning strategies available.
- Students were provided opportunities for qualitative reflections (Qualtrics™) such as making a study smart plan and exam wrappers to monitor and adjust their learning habits through metacognition.

Materials and Methods (Cont.)

- Exam Wrapper** - Students complete this reflective assignment once after their first summative assessment and then again before their final cumulative course assessment. Exam wrapper activity was evaluated through survey completion after quizzes. The survey included 10 items focused on their calculations quiz performance as well as preparation and their future quiz/exam test preparation.
- Objective Structured Clinical Examination (OSCEs)** - Students rotated through multi-station OSCEs comprising of calculations concepts. This occurred in the next semester about three months after their Pharmaceutical calculations course was completed.

Statistical Analysis

- The Wilcoxon signed rank test was used to determine the extent to which metacognition was enhanced over time.
- Chi-square tests and paired t-tests were used for testing the difference in means. Spearman's correlations were used to assess correlations between self-perception and related actual performance.
- We defined the significance level as p-values < 0.05. Statistical analysis was performed using Stata version 17.0.

Results

- There was a small statistically significance difference between students' perception and actual performance on two calculation concepts that are Milliequivalence (mEq) related to concentration, and Henderson-Hasselbalch ($p = 0.00 < 0.05$; $p = 0.00 < 0.05$ respectively) (Table 1).

Table 1. Student Perceptions and Actual Performance Using Chi-Square Test (n=74)

Topic	Perception		Actual Performance		P Value
	Yes	No	Yes	No	
Clearance	42 (56.76%)	32 (43.24%)	70 (94.59%)	4 (5.41%)	0.44
Intravenous (IV) infusion concepts	54 (72.97%)	20 (27.3)	68 (91.89%)	6 (8.11%)	0.71
Milliequivalence (mEq) related to concentration	53 (71.62%)	21 (28.38%)	52 (70.27%)	22 (29.73%)	0.00*
Dilutions and powder volume	65 (87.84%)	9 (12.16%)	18 (24.32%)	56 (75.68%)	0.88
Isotonicity and E-value	56 (75.68%)	18 (24.32%)	41 (55.41%)	33 (44.59%)	0.07
Pharmacokinetic concepts of Vd and Co	51 (68.92%)	23 (31.08%)	43 (58.11%)	31 (41.89%)	0.8
Henderson-Hasselbalch	42 (56.76%)	32 (43.24%)	39 (52.70%)	35 (47.30%)	0.00*
Half-life (pharmacokinetic)	60 (81.08%)	14 (18.92%)	51 (68.92%)	23 (31.08%)	0.29

Results (Cont.)

- The overall mean score of student perception is 4.55, while the overall mean actual score is 5.14, with the actual being greater than the perception. The mean perception score was smaller than the mean actual by 0.59 and it was statistically significant (P value 0.004, 95% CI= (-0.99, -0.19)). This finding implies that students' perception of their ability was much lower than their actual performance. (Table 2)

Table 2. Student Perceptions and Actual Performance Using Chi-Square Test (n=74)

Variable	Perception	Actual performance	Mean Difference	t (df)	P value	95% C.I.
Test result	4.55 (1.33)	5.14 (1.78)	-0.59	-2.94 (73)	0.00	(-0.99, -0.19)

Table 3. Responses given by the students to how thoroughly they worked the practice problems

	Exam wrapper Quiz 1; n (86) Mean (SD)	Exam wrapper Quiz 4; n (77) Mean (SD)
I thoroughly worked ALL the suggested practice problems*		
Yes	18 (20.22)	46 (59.74)
Most	25 (28.09)	15 (19.48)
Some	28 (31.46)	10 (12.99)
No	18 (20.22)	6 (7.79)

* P <0.05; SD = standard deviation

Questions with an increased positive responses in between the exam wrappers

I had enough effective study time before this quiz.

I approached the practice quiz on Examplify as if I was taking the actual quiz.

I worked out ALL the in-class handout questions on my own at least two days before the quiz.

Next time, I will

- Practice more problems so I know better how to set things up.
- Attend class and be attentive so I see more worked examples and clarify misconceptions early.
- Do the practice quiz at least 3 days before the quiz so I can learn from it.
- Read the question properly and try to understand what is being asked.
- Type my numbers in the calculator at least twice so I do not miss questions due to mistyping.
- Make sure I know how to round correctly.

Conclusion

- The students enrolled in the pharmaceutical calculations course were able to use their metacognitive skills to self-assess, and accordingly adjust their study strategies, and to achieve better performance outcomes.

References

- Joshi, M. D., & Klausner, E. A. (2022). Course design, delivery, and assessment strategies for pharmaceutical calculations course in a doctor of pharmacy program: A review. *Currents in Pharmacy Teaching and Learning*, 14(4), 526-535.
- American Association of Colleges of Pharmacy. (2023). AACP curriculum outcomes and entrustable professional activities (COEPA) 2022.
- National Association of Boards of Pharmacy. NAPLEX Competency Statement. <https://nabp.pharmacy/programs/examinations/naplex/competency-statements-2021/>
- Hartman, Hope J. "Metacognition in science teaching and learning." *Metacognition in learning and instruction: Theory, research and practice* (2001): 173-201.