

RESEARCH ARTICLE

Associating student learning and metacognition with performance in a first-year calculations course

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Abstract

Background: To assess the nature and strength of associations between learning activities that enhance metacognition and performance in a calculations course. **Methods:** All eighty-six first-year students enrolled in a Pharmaceutical Calculations course were invited to participate in the cross-sectional study. The learning management system (LMS), ExamSoft® testing software, and survey collection platform Qualtrics™ were used to build learning resources, formative assessments, and exam wrappers. Students were given chances to adjust their learning habits. In the following semester, they completed a calculations practicum that compared their perceived performance to their actual performance. **Results:** A positive correlation that is statistically significant was observed between summative quiz scores and the final examination score, with average quiz and final exam scores of 87 and 89 points out of 100, respectively. Early weekly formative quizzes showed positive correlations with summative quiz scores, especially at moderate to strong levels. Both types of quizzes were strong predictors of final exam performance. Students' perceptions of their understanding of Milliequivalence and the Henderson-Hasselbalch equation aligned with their actual performance, revealing a significant difference between perceived and actual scores. **Conclusion:** Formative resources utilised by students correlated with improved summative assessment scores, emphasising the importance of evidence-based strategies to improve learning pharmacy calculations. Integrating resources with assessments enhanced student awareness, retention, and academic performance.

Introduction

Pharmaceutical calculations are foundational to accurate medication preparation and administration. Pharmacists must master these skills to prevent medication errors (Joshi & Klausner, 2022). The significance of pharmaceutical calculations is emphasised in the AACP Curriculum Outcomes and Entrustable Professional Activities [COEPA] 2022 and comprises approximately 14% of the North American Pharmacist Licensure Examination [NAPLEX] (National Association of Boards of Pharmacy, 2021; American Association of Colleges of Pharmacy, 2022).

A recent review identified diverse teaching methods employed in pharmaceutical calculation instruction, including differentiated instruction, lecture-based and technology-based instruction, group and individual

learning, inquiry-based learning, kinesthetic learning, game-based learning, and expeditionary learning approaches (Joshi & Klausner, 2022). To prioritise student learning over instructor-centred teaching, educational research emphasises the crucial role of metacognition in fostering successful learning outcomes (Hartman, 2001). Metacognition is a multifaceted construct with various definitions (Mahdavi, 2014). For this study, metacognition is defined as a student's ability to reflect, monitor, plan, and thus have control over and self-regulate their own learning. Therefore, a vital component of teaching becomes the ability to guide students toward understanding and adjusting their study strategies to be successful learners. Students can thrive when faculty engage students and allow them to self-regulate and take control of their learning, with the idea that "Learning how to learn cannot be left to students. It

must be taught." (Gall *et al.*, 1990). Practice testing and spaced practice are proven, low-cost techniques that help students learn different content across many educational courses for learners of varying ages and abilities (Dunlosky & Rawson, 2015).

This study focuses on the effectiveness of a resource toolkit to meet contemporary pharmacy learners' needs. When faculty understand which study techniques are effective for certain skill sets, they can better advise students (Bartoszewski & Gurung, 2015; Ray *et al.*, 2018). Thus, the primary objective of this study was to examine the nature and strength of associations between learning activities that enhance metacognition and performance outcomes in a skills-based calculations course for first-year pharmacy students. Additionally, exam wrappers were incorporated into the course to foster this critical thinking (Lovett, 2013). Exam wrappers are reflective assignments designed to enhance students' metacognitive abilities by prompting them to analyse their study habits and learning strategies. Previous research has established exam wrappers as effective tools for augmenting student learning and promoting metacognitive control (Rivers *et al.*, 2020). Metacognition is an important trait to monitor and self-regulate one's study patterns for long-term memory and retention. Given the importance of metacognition for long-term retention, a calculations practicum was implemented to evaluate students' retention of math concepts three months after completion of the Pharmaceutical Calculations course.

Methods

The study was conducted during the Fall semester of the 2021-2022 academic year in a pharmacy school

located in the southern part of the United States. All incoming first-year pharmacy students enrolled in a two-credit hour Pharmaceutical Calculations course were invited to participate in the study. The course met twice weekly for 50-minute sessions. The study was reviewed and approved for exemption by the University's Institutional Review Board (IRB EXMT-P-21-F-3).

LMS and testing platform resources

Canvas was used to house the toolkit of various learning resources/activities, including pre-lecture videos, post-class question submissions, weekly formative content quizzes, and equation sheet templates. Additionally, students could complete formative quizzes on the testing platform ExamSoft®. These quizzes encompassed the same concepts as the summative tests with the same number of questions and time associated with completing them. Students were encouraged to complete this to aid their learning and find areas for improvement. Correlations were measured between in-course formative assessments (assessments *for* learning) and their effect on summative assessments (assessments *of* learning), including four quizzes and a final exam performance. Multiple formative assessments were used to facilitate student self-reflection and strategic planning. Some of these formative assignments had due dates and deadlines to keep students accountable, but incorrect answers were not penalised. The study design is described in Table 1, which includes the different formative resources laying the groundwork for student learning and the summative assessments that students could/had to complete during the semester. Some learning strategies that were used through these activities included retrieval practice with immediate feedback, spaced repetition and active recall, operant conditioning, self-reflection/monitoring, and self-testing to endorse effective study habits.

Table 1: Activities occurring along with the associated learning strategy, process, and timeline

Activity	Learning strategy	Process	Timeline
Canvas was used to create learning activities with immediate feedback. 1. Pre-class video snippets (n = 15). 2. Post-class concept questions (n = 7) 3. Weekly practice quizzes (n = 10)	Retrieval practice, Spaced repetition.	1. Students had access to short (~ 7 mins) video snippets in advance of class session. 2. Each week, students submitted their working solution to one question. Individual student feedback was provided as a comment. Weekly quizzes had 4 questions with 3 attempts to access the next module.	Throughout the semester.
Practice assessments (n = 5 for quizzes and exams) in ExamSoft®.	Operant conditioning to testing, Self-regulation, Retrieval practice.	Students had up to 25 attempts to take these practice assessments <i>for</i> learning as they studied.	A week before each summative assessment.

Activity	Learning strategy	Process	Timeline
Summative assessments (n = 4 for Quizzes) in ExamSoft®.	Chunking content, Monitor and plan study.	Students have non-cumulative quiz assessments <i>of</i> learning throughout the semester.	Spread throughout the semester.
Exam-wrapper reflections (n = 2), through Qualtrics™.	Plan, Reflect, & Monitor – this promotes metacognition.	Students received an email with a link/QR code to complete this reflective assignment.	Within 48 hours of completing the summative quizzes, twice in the semester.
Cumulative summative final exam (n = 1).	Encourages students to learn for long-term retention	This final assessment was an assessments <i>of</i> learning throughout the semester.	During the week of Final exams
Calculations practicums longitudinally through the curriculum (n = 1).	Retrieval practice, spaced repetition, active recall, self-regulated learning.	Students rotate through multiple stations comprising of calculations concepts that were taught in the course.	Semester after the calculations course.

Exam wrapper reflection

To understand the importance of guided self-reflection, students were given a ten minute overview of what an exam wrapper accomplished and the value of planning the learning process to achieve desired (student-set) goals and outcomes with the aid of actionable items (Bowen & Watson, 2017). The exam wrapper included summarising method of studying, time for focused study, and type of focused study for the calculation quizzes. Ten items focused on how students prepared for and performed on the quiz, whereas four items asked students to reflect upon their preparation for future quizzes (Appendix B). Within 48 hours of completing their first and fourth summative quiz in the course they were requested to fill out an exam wrapper via Qualtrics™.

Calculations practicum

Three months after completing the course, in the subsequent semester, students rotated through an eight-station Objective Structured Clinical Examination (OSCE) comprising calculations concepts. The students completed a Yes/No Qualtrics perception survey on their confidence to answer specific calculation concepts before the practicum. Students then moved through the eight-station practicum (with eight different calculations concepts) for ten minutes each. The topics included are listed in Table II and the eight topics were used to determine the mean scores for perception and actual performance. Correlations were measured between students’ perception of their knowledge and their actual performance on the different math concepts.

Table II: Student responses in the exam wrapper to how thoroughly they worked on practice problems

I thoroughly worked ALL the suggested practice problems	Exam wrapper Quiz 1; n (86) Mean (SD)	Exam wrapper Quiz 4; n (77) Mean (SD)
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)

Abbreviations: M = mean; SD = standard deviation

Statistical analysis

A Pearson correlation analysis was conducted to examine relationships between formative and summative assessments. The Wilcoxon signed-rank test was used to assess changes in metacognition over time. Differences in means were determined using chi-square tests for categorical data and paired t-tests for continuous data. Spearman's correlation analysis was employed to evaluate the relationship between self-perception and actual performance. In the analysis, missing data were excluded to maintain the integrity of the results, ensuring that only complete cases were considered for statistical evaluation. The significance level was set to *p*-values < 0.05. Statistical analysis was performed using Stata version 17.0.

Results

Summative versus formative tests in LMS and ExamSoft®

All assessments were scored out of 100 points. Students averaged 68.3 points on multiple attempts of LMS practice quizzes. Their average performance on the four summative quizzes was 87 points, and they achieved an average of 89 points on the final

examination (Figure 1). A statistically significant and positive correlation was observed between the scores

of the first and second LMS practice quiz attempts and the scores in the first and second summative quizzes.

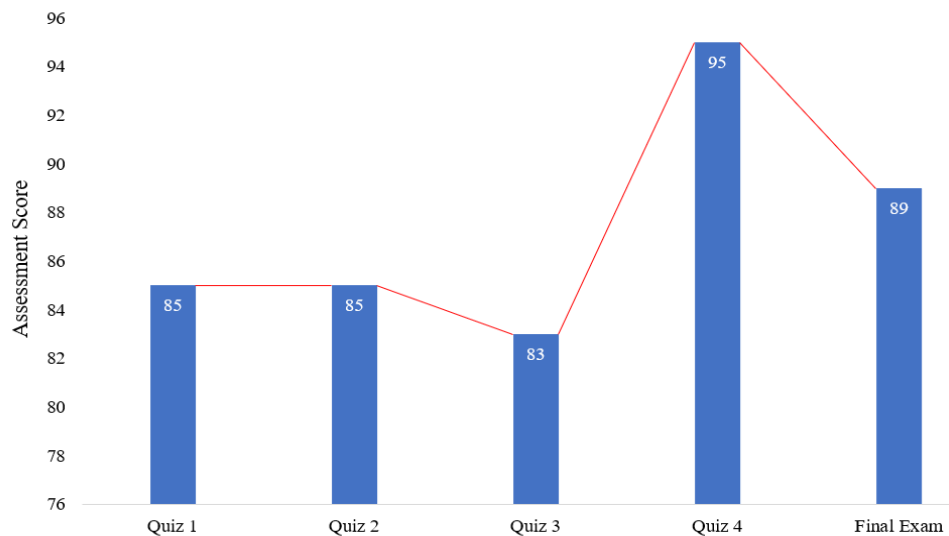


Figure 1: Mean scores on quizzes and final examination (out of a maximum of 100 points)

Moreover, a significant and positive correlation was identified between scores obtained in ExamSoft® practice quizzes and those achieved in summative quizzes (Figure 2). This finding suggests that an increase in the scores of practice quizzes was associated with a corresponding increase in summative quiz scores. Furthermore, a statistically significant and positive correlation was observed between scores on summative quizzes and the final examination. Additionally, a strong positive relationship was found between quiz scores and final exam performance. Quiz 1 ($r = .634$), Quiz 2 ($r = .636$), and Quiz 3 ($r = .638$) all showed strong correlations with the final exam ($p < 0.05$ for all). While Quiz 4 also correlated

significantly with the final exam ($r = .222, p < 0.05$), this relationship was smaller in magnitude. These results suggest that both formative and summative quizzes effectively predict student success in the course's final exam.

The relationship between the number of practice quizzes completed and final exam scores was analysed using Pearson's correlation coefficient. The analysis revealed a weak negative correlation ($r = -0.042, n = 83, p = 0.705$), which was not statistically significant. These results indicate no meaningful linear relationship between the number of practice quizzes completed and students' performance on the final exam.

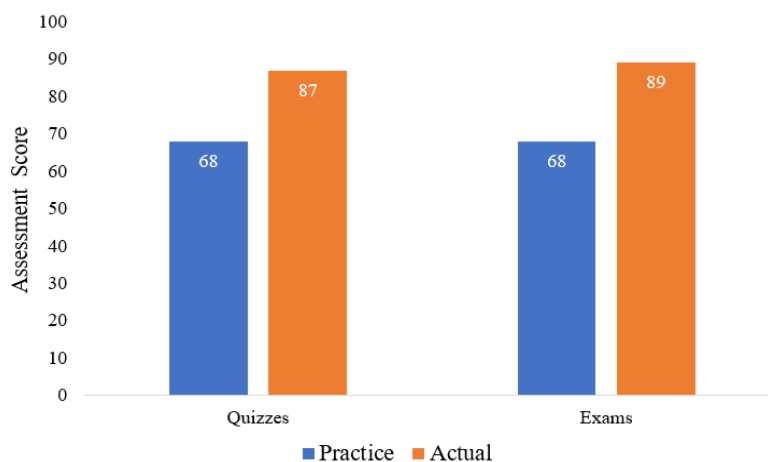


Figure 2: Formative versus summative assessment scores

Exam wrapper reflections

The wrapper included 14 items focused on their calculations quiz performance and their future quiz/exam test preparation (See Appendix B). Table II presents student feedback on how thoroughly they worked on practice problems, as collected through the Exam Wrapper. The percentage of students responding affirmatively to the statement "*I thoroughly worked ALL the suggested practice problems*" exhibited a marked increase from 18 participants during the first quiz to 46 participants by the fourth quiz, indicating a substantial enhancement in student engagement. Students

reported a heightened awareness and use of available study strategies such as practice quizzes and course material between Exam wrappers 1 & 2 (Appendix A).

Calculations practicum

Table III highlights a discrepancy between students' confidence and their actual performance on the calculation topics. Notably, students generally performed well in concepts like clearance and IV infusion, regardless of their confidence levels, as indicated by the high percentage of correct answers and non-significant *p*-values.

Table III: Student perceptions versus their actual performance categorised by calculation topics

Topic	Perception		Actual performance		P-value
	Confident on the concept	Not confident on the concept	Correct	Incorrect	
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%)	0.80
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

[†]Indicated statistical significance at $p < 0.05$

For the topics "*Milliequivalence related to concentration*" and the "*Henderson-Hasselbalch equation*," the *p*-values (< 0.05) indicate a statistically significant association between student confidence and their actual performance, suggesting that overconfidence or lack of confidence in these areas might align with actual understanding.

To facilitate statistical analysis, these percentages were converted into a standardised scale (see Table IV). The overall mean score for student perception was 4.55,

while the overall mean actual score was 5.14 for the 8-calculation concepts, indicating that their actual performance exceeded their perceived performance. The mean difference is negative (-0.59), indicating that students, on average, rated their perceived performance lower than their actual performance, with $p < 0.05$, indicating a statistically significant difference between perceived and actual performance. These results show that students significantly underestimated their performance on the calculation concepts.

Table IV: Results of student perceptions of performance versus their actual performance using chi-square test statistics (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)

Discussion

The results of this study reveal a noteworthy and statistically significant positive correlation between summative quizzes and final examination outcomes, administered in ExamSoft. The weekly LMS formative quizzes, administered throughout the course, also showed strong positive correlations with summative quiz scores, predominantly at moderate to strong levels. This indicates that both formative and summative assessments through the course are effective predictors of students' performance on the final exam. There was no meaningful linear relationship between the number of practice quizzes completed and students' performance on the final exam. Exam wrappers allowed students to reflect on their learning and they made changes as they progressed through the semester. In terms of student retention of calculations concepts gauged via the practicum three months post course completion, a significant discrepancy was noted between students' perceived and actual performance scores, with many students underestimating their capabilities during the practicum. However, students' perceptions regarding their understanding of key concepts such as Milliequivalence and the Henderson-Hasselbalch equation were consistent with their actual performance. These findings highlight the importance of addressing students' self-assessment skills to enhance their learning experience and outcomes.

Summative assessments in the calculations course are a key component for learning and showed significant and meaningful positive correlation to the final examination results. Such a correlation underscores the importance of chunking material into smaller assessments, like quizzes, in preparing students for high-stakes cumulative assessments/evaluations. Szpunar et al. (2007) found that when students were aware of a final cumulative test, they showed better performance on initial tests (Szpunar *et al.*, 2007; Raupach *et al.*, 2013). Additionally, the expectation of a cumulative test encourages students to employ the Ebbinghaus Forgetting Curve, which positively affects long-term retention (Ebbinghaus 1913/1885). Multi-point testing directly affects learning, encourages students to study more, engage with the material, experience less test anxiety, and utilise it as practice for standardised tests (Roediger & Karpicke, 2006). This insight emphasises the value of integrating regular summative assessments into the curriculum to foster student achievement and improve educational outcomes (Harlen *et al.*, 2002). By reinforcing learning and providing opportunities through no-stakes LMS weekly formative/practice quizzes, students are further encouraged to enhance their understanding and retention of material, ultimately contributing to their overall success on summative course assessments

(Raupach, *et al.*, 2013; Hennig *et al.*, 2019). In research conducted by Dunlosky, practice testing showed an effect not only to boost learning of tested information but also to help students indirectly identify knowledge gaps (Dunlosky & Rawson, 2015; Hartwig & Dunlosky, 2012). The utilisation of practice testing demonstrated a positive relation with examination scores from two introductory-level university classes (Bartoszewski & Gurung, 2015). This study supports this theory as students who performed well on the formative quizzes (in LMS and Examsoft) and exams did better on the summative assessments. Formative quizzes in ExamSoft® developed as part of this Pharmaceutical Calculations course helped prepare students for the rigor (similar content areas) and stress (same testing platform) of the summative assessments. The strong positive correlation between student engagement in formative learning activities and performance on summative assessments is both unsurprising and anticipated. This finding can largely be attributed to student self-regulation, which is the ability of students to manage their own learning processes, including setting goals, monitoring their progress, and adjusting their strategies to achieve academic success (Winne 2018; Linden *et al.*, 2021). Self-regulation is an important skill needed by students starting a professional degree program in context with a transition to graduate-level courses, onset of independence, and self-efficacy (Chemers *et al.*, 2001).

This study found no evidence of a significant relationship between the number of practice quizzes completed and final exam performance. Several factors may account for these findings. First, the lack of consequences associated with the practice quizzes may lead some students to approach them less seriously, viewing them primarily as tools for self-assessment rather than as genuine preparation efforts. For instance, some students might take the quizzes before studying to assess their initial understanding of the material instead of after actively reviewing the content. Second, external factors such as differences in exam preparation habits, time management skills, or motivation levels may also dilute any potential relationship between practice quiz completion and final exam performance. These combined factors may explain the observed absence of a meaningful linear relationship in these findings.

When students use techniques that foster deep processing of the course information, it is likely to have a better learning outcome (Dunlosky & Rawson, 2015). Persky and Hudson found that students who actively seek to enhance their study skills tend to adopt retrieval practices (Persky & Hudson, 2016). Many students can outline a plan of study, but few are able to follow their plan to find resources to close gaps and follow through to effectively learn (Stanton *et al.*, 2015). To give all students equitable access, this study provided a toolkit

(listed in Table I) that students could employ as needed to facilitate their academic goal achievement. While Hegener et al justified that a mandatory Pharmaceutical Calculations course would enhance proficiency in both fundamental and application-based calculations; this study identified practices and provided student resources within the course that would help students with learning outcomes (Hegener *et al.*, 2013). Faculty could effectively use these instructional strategies to engage student learning whilst refining their understanding of good learning strategies (Persky & Dinsmore, 2019).

Another tool provided to students was the exam wrapper which provided a way of reflecting on their quiz performances and planning for future course assessments. The percentage of students who reported working more practice problems to learn exhibited a 2.5-fold increase (from 18 students to 46 students) from the start to end of the course (Table II), indicating a substantial enhancement in student engagement. Students also relayed an increase in awareness and use of available study strategies from Exam wrappers 1 to 2 (Appendix A). Pate et al. (2019) found a statistically insignificant rise in the average exam performance among students who engaged in exam-wrapper activities, which suggests the potential utility of exam wrappers as an additional metacognitive tool for enhancing exam review processes (Pate *et al.*, 2019). Correlational analyses unveiled a connection between improved metacognition and enhanced learning for students who completed an exam wrapper (Soicher & Gurung, 2017). Student reflections to question 13 of the exam wrapper (Appendix B) showed a theme where students minimised distractions by setting aside their phones or turning off social media in both the exam wrappers. Research shows that studying while engaging with text messages or email correspondence among students is a prevalent albeit detrimental practice when studying (Persky & Hudson, 2016).

Regarding the post-course calculations practicum, *p*-values indicated a statistically significant association between student perception and their actual performance on concepts such as milliequivalence and the Henderson-Hasselbalch equation. This alignment suggests that students who felt confident in their grasp of these topics achieved higher scores on assessments related to them. Such consistency between self-assessment and actual performance points to the effectiveness of self-evaluation as a tool for learning. When students accurately perceive their understanding, it can lead to more targeted study efforts and improved academic outcomes (Ferla *et al.*, 2010). Furthermore, this correlation highlights the importance of fostering metacognitive skills in students, enabling them to assess their knowledge accurately and identify areas for further

improvement. These insights reinforce the critical role of student self-perception in the learning process and its impact on academic success. Overall, there was a significant discrepancy between students' perceived performance and their actual scores on the practicum where many students tended to underestimate their capabilities. This gap suggests that students may lack confidence in their skills or may not fully recognise the extent of their knowledge and abilities in practical settings. Such underestimation can have detrimental effects on their learning experience, potentially leading to decreased motivation and engagement. This finding underscores the importance of providing students with constructive feedback and opportunities for self-reflection, allowing them to better understand their strengths and areas for development. By addressing this misalignment between perception and reality, educators can enhance student confidence and foster a more accurate self-assessment process, ultimately improving performance outcomes in practical applications. This can be achieved by providing more formative assessments, feedback, and opportunities for reflection to help students better gauge their mastery of complex concepts.

Table I shows all resources that students had access to during the course as formative activities. The LMS post-class question assignment was designed to provide direct and immediate feedback to students to help with clarifying misinformation or confirming students' learning. It also gave faculty insight into if students were struggling with a topic and could choose to intervene. Receiving feedback on assignments with low stakes helps students feel more confident in their ability to be accurate and can justify the use of dynamic educational tools to help with student engagement in the learning process (Maher *et al.*, 2020).

In this study, students had the opportunity to engage with the LMS practice quizzes every week outside the classroom, even without additional incentives. This type of formative spaced practice empowers students to understand their level of knowledge and subsequently focus their efforts on mastering less familiar content. Self-testing is an active learning mechanism, which triggers student engagement and provides corrective insights for metacognitive monitoring. This highlights how important it is to explain the importance of spaced practice and retrieval practice, followed by provision for students to use resources without penalty, with the potential of fostering self-regulated learning (Ariel & Karpicke, 2018).

Among the effective pedagogical strategies, researchers have demonstrated predictive capabilities regarding pharmacy calculations performance such as flipped classrooms, self-directed bridging courses, utilisation of

video podcasts, personalised feedback, implementation of Gagne's nine events of instructional design, provision of online practice opportunities accompanied by feedback, and the application of self-testing, among others (Nutan & Demps, 2014; Stewart *et al.*, 2014; Cotta *et al.*, 2016; Flood *et al.*, 2017; Davies *et al.*, 2018; Gillette *et al.*, 2018; Maher *et al.*, 2020; Verdone *et al.*, 2020). Similarly, this study focused on using formative practices and looked for associations between them and course performance.

While this initial investigation into utilisation of metacognition among pharmacy students in a calculation course lays the foundation for further exploration, it is crucial to acknowledge and consider certain limitations. Students willingly engaged in the practice quizzes; however, it should be noted that the absence of quiz participation does not necessarily indicate a lack of involvement in alternative forms of self-directed learning among other students. Factors such as background knowledge, familiarity with the subject, and motivation to learn that can significantly influence performance in the course were not considered. The study was conducted without a control group. The focus on a single institution in this study of a singular course may restrict the generalisability of the intervention to a broader programmatic context.

Conclusion

In the Pharmaceutical Calculations course, students were provided a toolkit to encourage their metacognitive abilities. They could monitor and adjust their study strategies to improve their academic performance outcomes as desired. Earlier formative practices were instrumental in enhancing students' scores on summative quizzes, and better summative quiz performances correlated positively with the cumulative final exam. Conducting longitudinal tracking of student performance through the calculation practicum stood out as a potentially advantageous strategy for reinforcing calculation concepts over an extended period. This course-specific educational initiative should encourage faculty to utilise similar practices or create their own toolkit of activities that can be implemented as curricular adaptations to promote student growth and learning.

Conflict of interest

The authors declare no conflict of interest.

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Ethics approval

This study was conducted in accordance with the ethical standards set forth by the Samford University Institutional Review Board and received an exemption under exemption number (IRB EXMT-P-21-F-3).

Informed consent

Participation was entirely voluntary, and participants were provided with detailed information regarding the study's purpose, procedures, potential risks, and benefits. They were assured of their right to withdraw from the study at any time without any consequences.

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Appendix A: Questions that saw an increase in positive response/comments between exam wrappers 1 & 2 (after summative Quiz 1 versus summative Quiz 4)

Questions with an increase in positive responses between exam wrappers	
	Next time I will:
I had enough effective study time before this quiz	- Practice more problems so I know better how to set things up.
I approached the practice quiz on Exemplify as if I was taking the actual quiz.	- Attend class and be attentive so I see more worked examples and clarify misconceptions early.
I worked out ALL the in-class handout questions on my own at least two days before the quiz.	- Do the practice quiz at least three 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.

Appendix B: Exam wrapper questions that students completed within 48-hours of finishing Quiz 1 and Quiz 4 in the Calculations course.

Questions	Exam wrapper survey items
Section 1: Your calculations quiz performance and preparation	
1	I received a grade I expected based on the effort I put into studying
2	I thought that I was well prepared for this quiz.
3	In Exemplify, did the rationale together with the solutions in the review, provide you with adequate feedback?
4	Prior to the quiz, I explained practice problems to someone else to reinforce my learning of the concepts.
5	I had enough effective study time before this quiz.
6	I approached the practice quiz on Exemplify as if I was taking the actual quiz.
7	I worked out ALL the in-class handout questions on my own at least two days before the quiz.
8	Study strategies to prepare for the Quiz in Pharmaceutical Calculations: (Select all that apply) <ul style="list-style-type: none"> - Related new material to things you already know - Found related online content - Spaced your retrieval practice - Mixed in multiple courses to study each day - Took study breaks in between practice - Re-read handouts or re-watched videos - Explained to someone familiar with content - Explained to friend/roommate/family (unfamiliar with content) - Attended review session - Sought out another individual's help - Visited professor's office hours - Responded to professor's pre-post question email for seeking help - Completed Exemplify practice test - Completed weekly Canvas quizzes
9	List the reason/s for why you had difficulties answering questions correctly: (Select all that apply) <ul style="list-style-type: none"> - I understood the questions in the handouts but could not transfer my knowledge to the quiz questions. - I was overconfident in my level of understanding of the material and preparation for the exam. - I did not go through the practice quiz on Exemplify. - I did not do enough practice (textbook and other) problems. - I did not understand the question being asked. - I did not pay sufficient attention in class; I allowed myself to be distracted. - I did not pay sufficient attention while studying and allowed myself to be distracted. - I missed it due to mistyping the numbers on my calculator. - I was not paying attention to units. - I made rounding errors. - I did not know the answer, so I guessed. - I answered all questions correctly.
10	Next time, I will: (Select all that apply) <ul style="list-style-type: none"> - 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 three days before the quiz so I can learn from it - Minimise distractions in class - Try not to get distracted and/or multitask while studying. - 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. - Pay attention to units being asked. - Make sure I know how to round correctly. - I'm happy with my grade and I will continue to study the same way to get it again.
Section 2: Your future quiz/test preparation	
11	How many days before the next quiz will you begin reviewing and studying the materials?
12	About how many sessions/times per week do you plan to study calculations for the next quiz?
13	Have you been able to successfully minimise distraction while studying (since the start of the semester). If yes, how?
14	Do you think your target grade is still achievable?