Associating Student Learning and Metacognition with Performance in a First-year Calculations Course

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Background

- The science of teaching and learning has shown that metacognition is important for learning to be successful.
- For purposes of this study, we define student's metacognition as their ability to reflect, monitor, and plan for effective learning in a course-specific manner.
- We focused on developing ways to meet the contemporary learners' needs and provide opportunities for implementation of necessary curricular adaptations that can engage the academy in new avenues for teaching and learning (AACP's strategic priority #2, objectives 2.1.2 and 2.1.3.)[1]
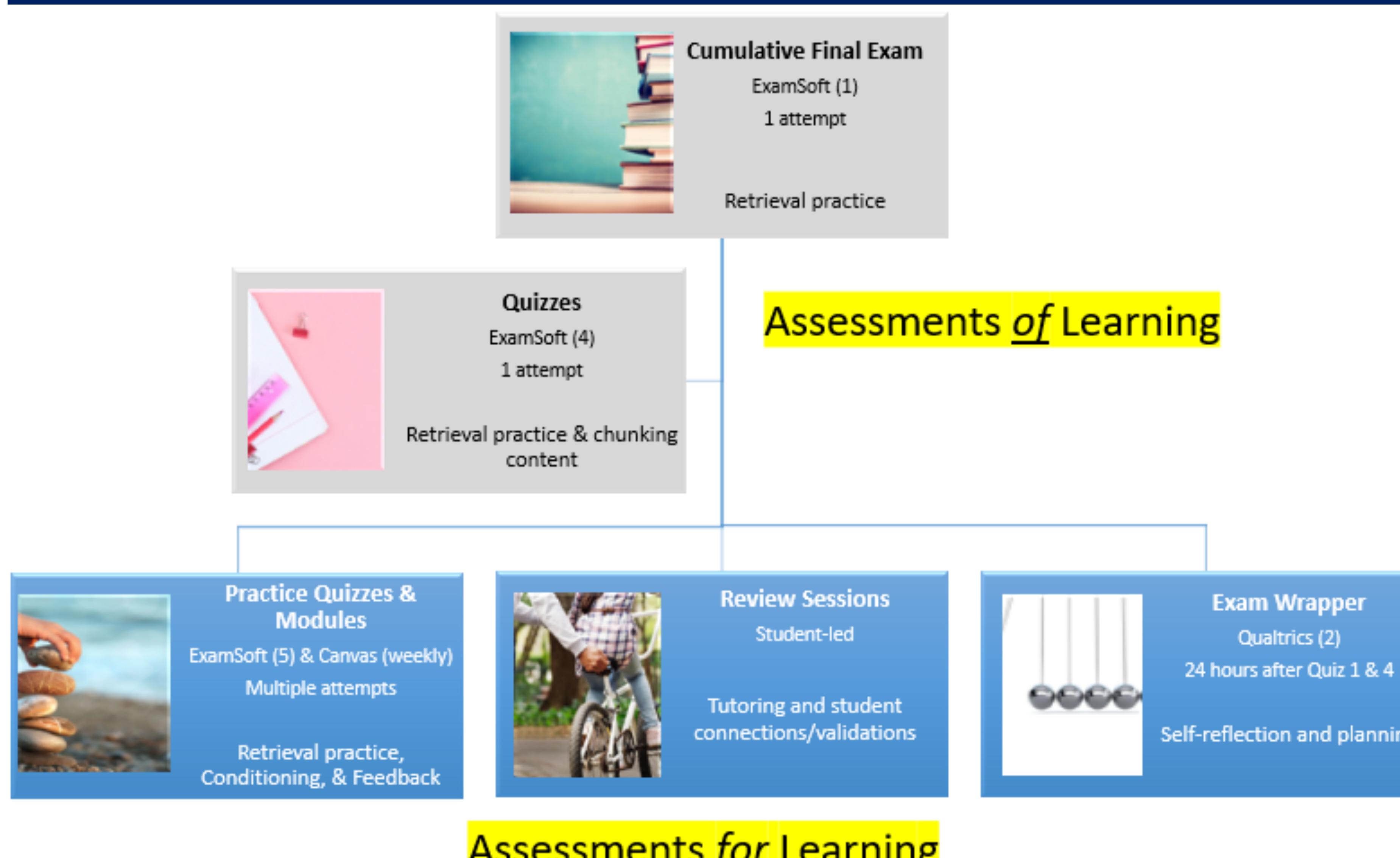
Purpose

- To examine the nature and strength of associations between learning activities that enhance metacognition with performance outcomes in a skills-based calculations course in first professional-year pharmacy students.

Course Information

- First-year pharmacy (PharmD) students in a Pharmaceutical Calculations course at Samford University.
- This course was designed to give students multiple formative (practice) assessments in a structured manner. We presented a myriad of resources to students during the course to encourage effective learning strategies that are grounded in educational research.
- Retrieval practice with immediate feedback, spaced repetition and active recall, operant conditioning, self-reflection/monitoring, and self-testing were strategies used to develop and endorse effective study habits.

Design

Cumulative Final Exam
ExamSoft (1)
1 attempt
Retrieval practice

Quizzes
ExamSoft (4)
1 attempt
Retrieval practice & chunking content

==Assessments *of* Learning==

Practice Quizzes & Modules
ExamSoft (5) & Canvas (weekly)
Multiple attempts
Retrieval practice, Conditioning, & Feedback

Review Sessions
Student-led
Tutoring and student connections/validations

Exam Wrapper
Qualtrics (2)
24 hours after Quiz 1 & 4
Self-reflection and planning

==Assessments *for* Learning==

References

1. American Association of Colleges of Pharmacy. (2023). 2021-2024 Strategic Plan Priorities, Goals and Objectives.
2. Gall MD, Gall JP, Jacobsen DR, Bullock TL. Tools For Learning: A Guide to Teaching Study Skills. Assn for Supervision & Curriculum; 1990.

Methods

Activity	Learning Strategy	Process	Timeline
Canvas, our LMS*, was used to create learning activities with immediate feedback. 1. Pre-lecture video snippets. 2. Post-class concept questions 3. Practice Module quizzes	Retrieval practice with immediate feedback, and spaced repetition.	1. Students had time at the end of class each week to submit their solution to one question. Individual student feedback was provided as comments through Canvas. 2. Weekly canvas module quizzes had 4 questions and students needed to get ≥75% score with 3 attempts to access the next module.	Throughout the semester.
Practice assessments (quizzes and exams) in *ExamSoft/Examplify*, their online testing system.	Operant conditioning to testing format, opportunity to self-regulate, and retrieval practice.	Students had upto 25 attempts to take the practice for learning as they studied.	A week before each summative assessment.
Exam-wrapper reflections, through *Qualtrics™.*	Plan, self-reflect, and monitor, to promote metacognition.	Students were sent an email with a link/QR code to complete this reflective assignment.	Within 24-hours of summative quizzes, twice in the semester.
Summative quizzes in *ExamSoft/Examplify.*	Assessment *of learning* in manageable chunks. Allows students to monitor and plan study.	Students have non-cumulative quizzes throughout the semester.	Four quizzes through the semester.
Calculations Practicums longitudinally through the curriculum.	Retrieval practice, spaced repetition, active recall, self-regulated learning.	Students rotate through multiple stations comprising of calculations concepts that were taught in the course. This will occur at multiple stages of pharmacy curriculum.	*In process* - the first student cohort has gone through three practicums so far.

Results

- Pearson correlation was used to assess the correlations between:
  - the weekly canvas module attempts and the quizzes.
  - scores on practice quizzes and actual quiz scores.
  - quiz scores and cumulative final examination scores.
- The average score across module attempts was 2.73 out of a maximum of 4.
- The average score on the four quizzes was 87, while the average on the final exam was 89 points out of 100.
- There was a significant and positive correlation between the first and second module attempts and the scores in the first and second quizzes.
- There was a significant and positive correlation between the practice quizzes and actual quizzes, indicating that as the score of the practice quizzes increased, the score of the actual quizzes also increased.
- There was a significant and positive correlation between scores on quizzes and the score on the final examination: quiz 1 ($r = .634$, $p=0.00$, $n=83$), quiz 2 ($r = .636$, $p=0.00$, $n=83$), quiz 3 ($r = .638$, $p=0.00$, $n=83$), quiz 4 ($r = .222$, $p=0.00$, $n=83$).
- In most cases, the correlations were either moderate or strong. However, there was only a significant, albeit small correlation, between quiz 4 and the final exam.
- The practice quizzes and actual quizzes are strong predictors of final exam scores and final grades.

Figure 1. Average Quiz and Exam Scores
Quiz 1: 85, Quiz 2: 85, Quiz 3: 83, Quiz 4: 95, Final Exam: 89

Figure 2. Practice Versus Actual Assessment Scores
Quizzes — Practice: 68, Actual: 87; Exams — Practice: 68, Actual: 89

Summary

- Earlier formative practices helped students obtain better scores on summative quizzes and exams, and higher quiz scores helped students to perform better on the final exam.
- The academic rigor and course load in the first year of pharmacy school makes it vital for faculty to prepare students to be academically successful by guiding them towards effective learning strategies.
- This course-specific educational initiative should encourage faculty to create evidence-based practices that provides a toolkit of activities that can be implemented as curricular adaptations to promote student growth and success across the academy.
- 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".**[2]

*Learning management system