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Research

Online assessments in pharmaceutical calculations for enhancing feedback and practice opportunities

Mohammad T.H. Nutan, PhD*, Elaine L. Demps, PhD

Irma Lerma Rangel College of Pharmacy, Texas A&M Health Science Center, Kingsville, TX

Abstract

Objectives: The objectives of the study were to evaluate the effectiveness of, and student preference for, an online approach to carrying out the formative assessments of a first-year pharmaceutical calculations course. Traditionally, these assessments were completed as in-class paper–pencil Scantron® quizzes. After the change, they were completed online as homework assignments with detailed feedback and ample opportunities for repeated practice once the assignments were graded.

Methods: Classes of 2012, 2013, and 2014 students in the Doctor of Pharmacy program at Texas A&M Rangel College of Pharmacy completed these formative assessments online using WebCT or Blackboard. Individualized question sets were randomly constructed from a question pool containing multiple-choice questions and presented as online homework. The effectiveness of this approach was measured by comparing the overall course grades of these classes with the Classes of 2010 and 2011, who completed the paper–pencil Scantron® quizzes. Student preference for the online approach was assessed by a survey.

Results: The course grades of Classes of 2012 and 2013 were significantly greater than those of Class of 2010. The differences in grades between the other classes were not significant. More than 90% of students favored the online approach and provided valuable comments about the benefits of detailed feedback and repeated practice.

Conclusions: Students preferred the online homework assignments. The online approach maintained or improved the student grade. Once the question pool is developed, instructors can provide detailed feedback to students very efficiently. Formative assessments for pharmaceutical calculations can be done online more conveniently than the traditional paper–pencil approach.

Keywords: Pharmaceutical calculations; Formative assessments; Online assessments; Homework; Detailed feedback; Student learning

Introduction

Carrying out pharmaceutical calculations with high accuracy is viewed globally to be an important skill for various health care professionals—particularly physicians, nurses, and pharmacists.[1–8] In the United States, this skill is considered to be equally vital for pharmacists,[1,2] as evidenced by Appendix B of the Accreditation Council for Pharmacy Education (ACPE) standards and guidelines[9] and the North American Pharmacist Licensure Examination (NAPLEX) blueprint.[10] For example, in Appendix B, the subcategory of medication dispensing and distribution systems addresses skills and knowledge relevant to pharmaceutical calculations. Likewise, Area 2 of the NAPLEX blueprint, which comprises 33% of the licensure exam, includes competencies on pharmaceutical calculations. As a result, pharmaceutical calculations constitute a vital part of any pharmacy curriculum. However, students often seem to feel uncomfortable in these types of courses, even if the calculations they carry out may not involve complicated mathematical operations.[1,11]

* Corresponding author: Mohammad T.H. Nutan, PhD, Irma Lerma Rangel College of Pharmacy, Texas A&M Health Science Center, 1010 West Avenue B, MSC 131, Kingsville, TX 78363.
E-mail: mnutan@pharmacy.tamhsc.edu

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Meanwhile, reports in the literature cite dosing errors as an important cause for adverse drug events and subsequent harm to patients.[12–15] Errors occurred most frequently at the ordering or prescribing stage,[13–15] followed by the administration and dispensing stages.[15] These studies also provide evidence that the errors were, and can be, prevented by staff pharmacists.[13,14] Hence, the topic of improving student learning in pharmaceutical calculations deserves special attention because the consequences of inaccurate dosing in real life can be serious or fatal.

Feedback, defined as "information given to students about their performance that guides future behavior,"[16] is a critical component of the learning process, impedes learning when it is absent, and reinforces learning when it is present.[17] Feedback serves to inform students how much they understand a topic, how well they can perform a skill, and where their future efforts should be directed toward achieving the overall learning goal.[16] Feedback can be general, such as an average exam score; specific, such as a correct solution to a calculations problem; or individualized, such as a comment pinpointing in which step a student made a calculations error. In terms of effectiveness, individualized feedback is most effective, followed by specific, followed by general.[16]

Formative assessment encompasses the evaluation opportunities through which feedback can be provided to students while they are acquiring a concept or skill.[18] Thus, formative assessment is another instrumental component in the learning process. While formative assessment and feedback individually are important components, their impact is most significant when combined and provided in the following sequence: (1) formative assessment, (2) timely and targeted feedback, and (3) additional related formative assessment opportunities to apply the feedback.[16]

Previously, as reported in a 2007 article, Brown and Hanggi[19] conducted a study to characterize the current strategies used in the instruction and assessment of pharmaceutical calculations in the nation. The study revealed that students in surveyed U.S. colleges and schools of pharmacy did not receive ample feedback on the calculations they performed on assessments. About 40% of the programs did not provide the solution of the problems given in exams and assignments. More than one-tenth and one-fifth of the programs did not even provide the most basic feedback, the correct answers in exams and assignments, respectively. This study showed there is a significant room and need for improvement in providing feedback in pharmaceutical calculations. Emphasizing this component of the teaching and learning experience could be addressed through online formative assessments developed using readily available tools in learning management systems such as Blackboard Learning System and WebCT (Blackboard Inc, Washington, DC).

Online instruction is a popular learning method in many areas of education, including pharmacy education.[20–25] However, as shown by Brown and Hanggi,[19] the overwhelming majority (94%) of pharmaceutical calculations courses are delivered face-to-face, with 13% of those courses making use of online study packets. Reports of pharmaceutical calculations courses that incorporate online resources are available. For example, at one college of pharmacy, an initial effort to teach a pharmaceutical calculations course mostly online was halted and transformed into a live course following students' dissatisfaction with lack of face-to-face contact with instructors and slow feedback on materials they did not understand.[26] After converting this course again to become self-paced, with students completing modules that made use of faculty-programmed web-based question sets for practice, the course was deemed successful.[26] Another example of incorporating online materials for a pharmaceutical calculations course used "pencasts," audio recordings of faculty explaining problem-solving steps as they completed the steps on paper.[27] Students reported that the pencasts enhanced their learning.

Calculations is a type of learning that requires ample practice opportunities,[28] comprehensive guidance from instructors, and extensive feedback. Therefore, the purpose of this study was to evaluate the effectiveness of, and student preference for, completing the formative assessments online as homework assignments with detailed feedback and multiple opportunities for practice. The effectiveness was measured by comparisons of the overall student course grades of each class that completed the online homework with those that completed the paper–pencil Scantron® quizzes. Student preference was evaluated by a six-item survey.

Methods

PHAR 641: Pharmaceutical Calculations is a two-credit hour required course conducted in the first semester of the first year in the four-year Doctor of Pharmacy curriculum at the Texas A&M Rangel College of Pharmacy. Using basic mathematics and quantitative reasoning skills, students learn to carry out calculations essential in compounding, dispensing, and clinical settings. This course has been offered at the college since 2006, beginning with its inaugural Class of 2010. It is taught by a single faculty member with no teaching assistant support. In its 50-minute duration, a typical class period includes the faculty member presenting a concept or theory, including its application, followed by demonstrations of problem solving. Thereafter, students independently solve one or more problems individually or in small groups. A class discussion and question-and-answer session concludes a topic. In this concluding part, the instructor shows the solution and emphasizes any critical steps that students may typically miss. The instructor also responds to the follow-up questions from the students.

This study focused on the changes to the formative assessments of Pharmaceutical Calculations among five classes of students: Classes of 2010 (C10), 2011 (C11), 2012 (C12), 2013 (C13), and 2014 (C14). The numbers of