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Research

Graduated quizzes in a diabetes mellitus therapeutics module and impact on student learning

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Abstract

Objective: To design a module that students reacted favorably to on diabetes mellitus medications that increases student retention of medication names (including brand and generic), mechanism of action, indications, side-effects (Black Box Warnings), route (and dose), and aids them in their ability to apply that knowledge to "real-world" patient cases.
Design: A graduated series of quizzes was created at three different levels based on Bloom's Taxonomy. Each quiz was opened once for students, followed by in-class feedback, and then re-opened for mastery.
Assessment: Students were surveyed and interviewed to better understand their use of and reactions to the graduated quizzes. Quiz and exam scores were also collected and analyzed.
Conclusions: Students responded favorably to this method of quiz taking. While there was no direct correlation between exam score and number or duration of quiz attempts in the population under study, nearly all students (about 95%) took the quizzes until they received a perfect score and many (about 36%) continued to use the quizzes as study guides. Culminating exam scores were compared between two student populations: students in the present study, who were given the graduated quizzes, were compared with students from the previous year, who were not given the mastery quizzes. The *t*-test showed a difference at the significance level of 0.05 in the scores for those who were given the graduated quizzes ($M = 84.24$, SD = 9.94), as compared to those who took the class before the graduated quizzes were instituted ($M = 82.58$, SD = 10.44), $p = 0.05$.

Keywords: Bloom's Taxonomy; Pharmacy; Feedback; Quizzes; Mastery Learning

Introduction

Educating pharmacists in the area of diabetes mellitus (DM) is increasingly important. An estimated 20 million people in the United States alone have the disease.[1] Diabetes mellitus is not only detrimental to physical health, but it also affects the lifestyles of those with it and their loved ones.

According to the American Association of Diabetes Educators (AADE): Diabetes mellitus is associated with long-term microvascular and macrovascular complications, including a two- to four-fold increased risk for cardiovascular events, and an annual mortality rate two to three times higher than that of individuals without diabetes mellitus. Approximately, one of every ten health care dollars is spent on diabetes mellitus and its complications. The estimated total cost of managing diabetes mellitus in 2007 was approximately $174 billion dollars and is estimated to continue increasing.[1]

The Scope and Standards for the Practice of Diabetes Education by Pharmacists was released in 2005 by the AADE and outlines the important role that pharmacists play

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in assisting patients with the disease. "Almost all medically managed patients with diabetes interact on an ongoing basis with a pharmacist. As such, pharmacists may have a profound influence on improving the lives of the patients with diabetes whom they see in their daily practice."[1]

In addition to aligning with the practice standards above, this re-design of a diabetes mellitus module instruction was also informed by and aligned with the Accreditation Council for Pharmaceutical Education (ACPE) competencies, more specifically Standard 11,[2] and the Center for the Advancement of Pharmacy Education (CAPE) educational outcomes, especially Domain 1—Foundational Knowledge and Domain 3—Approach to Practice and Care.[3] All of these advocate for a rich knowledge of the content that allows the pharmacist to develop and synthesize patient care solutions that go beyond a recall of multiple medication names and indications. In order to do this, pharmacy students need to learn at a variety of levels from knowledge and comprehension of drugs and indications to analysis and synthesis of that information when applied to patient cases.

In this re-design, we incorporated three graduated quizzes delivered through the college's Learning Management System (LMS). These quizzes were meant to encourage a scaffolded approach to learning the complexity of DM medication management and were delivered to the students in three phases. At the highest level of learning, the quizzes incorporated patient cases and place in therapy (i.e., first-line versus second-line option, cost-effectiveness, and patient history of compliance) as part of the quiz questions. Following each quiz, student learning was reinforced with detailed feedback from the professor based on student performance. This design was based on Bloom's Mastery Learning.

Mastery Learning, a theory proposed by Benjamin Bloom in 1968, posits that students at all levels should be able to master the material given sufficient time and instruction.[4] Lessons should be divided into smaller sections, preceded by an assessment to gauge the student's performance ability, and followed by feedback from the professor. The student is then allowed sufficient time to practice, learn, and develop their knowledge to a sufficient level before moving forward. Mastery Learning has been widely studied since its inception. In 1990, Kulik et al.[5] published a meta-analysis on Mastery Learning, which included a review of 108 studies. They concluded that, with some variations, Mastery Learning has a positive effect on student learning, with stronger results from weaker students, and that Mastery Learning may improve students' attitudes toward course content. These authors found no studies in the field of pharmacy education to include in their meta-analysis. The present study matched ideas of Mastery Learning in that the quizzes were self-paced, topics were reinforced with feedback from the professor, availability of quizzes allowed the students to pace themselves with sufficient time, and encouraged students to remain on task until a high or perfect score was reached. While some studies published in the field of pharmacy education since the Kulik et al. article address some of these elements of Mastery Learning, we were unable to find any one that addressed all. Of the eight studies that we found,[6–13] three[11–13] most closely matched these elements with the exception that feedback given to students was not detailed (e.g., students were told which questions they got right and/or wrong but not why). In all, two of these studies were conducted by the same group of authors and investigated self-testing and its effectiveness on exam scores. In a 2014 study by Panus et al.,[12] the researchers examined frequency of self-testing as it related to exam scores and found that "a consistent significant correlation ($p = 0.05$) existed between the number of practice quiz attempts and the subsequent examination scores." In the other study, these researchers examined whether scores on the self-tests related to exam scores. They found that "during the first 3 of the 4 testing periods, the improvement in practice quiz averages was consistently reflected by a similar magnitude of change in the examination score."[13] In a 2004 study by Franic,[11] the researcher examined how a number of teaching elements, including WebCT quizzes, affected students' exam scores. Results indicated that "the number of WebCT quizzes completed positively correlated with examination scores."[11]

An essential part of Mastery Learning is effective feedback from the instructor. The type of learning we hoped to see, which gradually builds to higher levels of knowledge and skills, needed a support structure in place for the students. To support their learning, we included in the re-design a series of feedback sessions, which were to follow each quiz. In a 2008 meta-analysis that included a review of 40 reports, Bangert-Drowns et al.[14] found that feedback was more effective when the correct answer choice was indicated, as opposed to just marking the answer wrong. Also in 2008, Butler et al.[15] found that feedback tended to correct wrong answers. Further, they found that feedback also helped to reinforce correct answers, especially when students were less confident about their initial correct answer. "Consistent with prior research, feedback improved retention by allowing subjects to correct initially erroneous responses. Of more importance, feedback also doubled the retention of correct low-confidence responses, relative to providing no feedback. The function of feedback is to correct both memory errors and metacognitive errors."[15]

The highest levels of the quiz questions included case-based questions. Case-based learning (CBL) is a widely used practice in education in general as well as pharmacy education specifically.[16] In an effort to better understand the definition and place of CBL, Thistlewaite et al.[17] reviewed 104 papers in the fields of medicine, dentistry, veterinary science, nursing and midwifery, social care, and the allied health professions. Based on the papers they reviewed, they state that the "goal of CBL is to prepare students for clinical practice, through the use of authentic clinical cases. It links theory to practice, through the application of knowledge to the cases, using inquiry-based learning methods."[17] They