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Incorporation of practice testing to improve knowledge acquisition in a pharmacotherapy course

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ABSTRACT

Background and purpose: To incorporate and assess the impact of a coordinated practice testing activity on pharmacy student knowledge acquisition, retention, and perception as an effective study technique in a pharmacotherapy course.*Educational activity and setting:* Students were instructed to individually create, exchange, complete, and discuss solutions to weekly, cumulative practice tests of targeted material during the first unit of the course. Students completed surveys on their perceptions of practice testing. Unit and final examination scores were compared to the previous year.*Findings:* Comparison of average unit examinations scores showed only minimal improvement in knowledge acquisition, and no impact was detected in knowledge retention. Most students in the course did not perceive practice testing to be beneficial in learning or retaining unit material.*Discussion and summary:* Incorporating a coordinated practice testing activity may have minimally improved knowledge acquisition in our pharmacotherapy course. However, limitations exist which make it difficult to attribute improvement solely to our learning activity.

Background and purpose

The curriculum of Concordia University Wisconsin Doctor of Pharmacy requires students to complete a five-course pharmacotherapy series. In the series' final course, the first of three units (Unit 1) covers men's and women's health topics. Unit 1 has historically been a challenging unit for students. Faculty and administrators have postulated a variety of factors that may impact students' ability to demonstrate achievement of course learning objectives. These include the timing of the course in the professional curriculum, number of topics, wide range of disease states, and multiple instructors who teach in the unit. Course revisions have been made to help control these factors such as reducing the number of topics and consolidating instructors. However, additional strategies were needed to improve students' acquisition and retention of the material in Unit 1.

In our review of techniques aimed at improving student learning, we found practice testing most appealing. Practice testing or test-enhanced learning which uses testing as a means to facilitate retrieval practice is well researched. Recent review articles report over 100 years of research starting with a seminal 1909 article by Abbott¹ and a very active area of psychological and educational research in the past 10 years resulting in over 120 publications.^{2,3} This plethora of research has shown practice testing promotes knowledge acquisition and retention.^{4–7} Additionally, research has shown practice testing increases the ability of students to retain information when compared to repeated study.^{4,8–12} This finding was a valuable discovery because we wanted to implement an activity which could have additional impact on learning. We predicted many of our students lacked awareness of practice testing

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benefits and employed restudying over recalling material to prepare for examinations, similar to results reported by Hagemeyer and Mason¹³ in their survey of student pharmacists' perceptions of testing and study strategies. These published findings were similar to previous studies conducted in non-pharmacy student populations.^{14,15}

Practice testing has been described in a variety of formats and conditions. Overall, beneficial testing effects have been shown using multiple choice, short answer, fill-in-the-blank, and open book practice tests, as well as those that utilize memory or comprehension.^{10,16–21} Although some research suggests practice testing using short-answer format is more effective than multiple-choice format because more effortful processing is required,^{22,23} one study by Smith and Karpicke²⁴ found the effects of practice testing among different formats similar. Testing effects also persist if the format of the practice test does not match the format of the summative assessment.^{21,25–29} We felt the broad applicability of practice testing represented in these findings would allow us to customize our practice testing activity to best fit our course and existing resources.

The use of practice testing has been described in a variety of healthcare and basic science courses.^{8,30–40} Though, the impact of practice testing as a study technique in pharmacy education has been reported minimally in the literature, initial studies have been promising. Stewart et al.³¹ demonstrated correlation between student performance on practice tests and examination scores when first-year pharmacy students were given access to optional, instructor-created, non-graded, online, multiple-choice, practice quizzes prior to examinations in a pathophysiology course. However, retention of knowledge within this study was not assessed. A recent study demonstrating improvement on examinations when pharmacy students used optional, instructor-created, non-graded, online, multiple-choice and matching practice modules to study immunology and medicinal chemistry topics produced preliminary data showing knowledge retention may also improve.³² The author noted, however, that more robust studies analyzing impact on knowledge retention are needed.

Because of the broad applicability and well-validated benefits of practice testing on knowledge acquisition and retention, we designed a practice testing activity within our pharmacotherapy course. Our goals were to observe an improvement in students' knowledge acquisition, knowledge retention, and perception of practice testing as an effective study technique.

Educational activity and setting

Our pharmacotherapy course is a 16-week, traditional lecture-based course. Unit 1 provides 18 hours of content over the span of five weeks. In 2014, we implemented our practice testing activity during the first four weeks of Unit 1. In the first week, students received didactic instruction on the benefits of practice testing, test item writing, as well as activity details and schedule (Table 1). We felt we needed to educate students on the benefits of practice testing and design a low-stakes learning activity to encourage participation due to the reported lack of awareness of practice testing benefits among pharmacy students.¹³

Outside of classroom time, students were instructed to individually create four weekly, cumulative practice tests based on instructor-created learning objectives of course material. Students were required to include at least one practice test item per topic assigned. For example, for the Week 1 practice test, students were required to develop one item on menstruation-related disorders, one item on polycystic ovarian syndrome, and one item on contraception. To emphasize repetition which is beneficial in retrieval practice,^{11,41} cumulative practice tests were required. For example, for the Week 3 practice test, students were required to generate a total of nine items, one for each topic that had been covered thus far in the course. These items would, therefore, include both new content from that week as well as content previously covered in the Unit. The fifth week of the course contained both Unit 1 and Unit 2 content; therefore, Week 5 – Unit 1 content was omitted from the practice testing activity due to logistics.

Student-created practice test items could include multiple-choice, short-answer, or fill-in-the-blank items to promote student compliance with the activity. Practice test item level of difficulty was not specified. Students were instructed to exchange, complete, and discuss solutions to practice tests with a self-selected partner. Solution discussion was included in the activity as feedback may enhance the testing effect.^{42,43} After creation, students submitted practice tests to the instructor via electronic learning management system to receive credit as an incentive for completing the activity. However, instructors did not review practice test items or solutions due to time limitations and the volume of test items created.

Credit for completion of all four weeks of the activity accounted for 0.6% of the overall class score to emphasize a low-stakes activity which did not have considerable impact on the students' final grades, but still provided some incentive for completion. Unit examinations given at the end of each unit were comprised of multiple-choice and fill-in-the-blank items. The comprehensive final examination, given at the end of the course, was comprised of multiple-choice items only. After completing the unit and final examinations, students were administered electronic surveys regarding compliance and perceptions of practice testing. Concordia

Table 1
Practice testing activity schedule in pharmacotherapy course.

Week	Topics	Minimum number of practice test items
1	MRD, Infertility/PCOS, Contraception	3
2	Week 1 topics + PL, STI, PMD	6
3	Weeks 1 & 2 topics + Breast Cancer, Ovarian Cancer, Menopause	9
4	Weeks 1–3 topics + Osteoporosis, ED, Prostate Cancer	12

MRD: menstruation-related disorders; PCOS: polycystic ovarian syndrome; PL: pregnancy and lactation; STI: sexually transmitted infections; PMD: perinatal mood disorders; ED: erectile dysfunction.

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