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Experiences in Teaching and Learning

An evaluation of student performance and perceptions within an integrated pharmaceutics course sequence

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ABSTRACT

Background and purpose: To describe the design of an integrated pharmaceutics course sequence and to assess the sequence by evaluating both student performance and perceptions.
Educational activity and setting: The non-sterile products portion of a pharmaceutics course sequence was designed to integrate the disciplines of physical pharmacy, dosage forms, pharmacy compounding, and pharmaceutical calculations and to include the respective topics deemed most relevant to doctor of pharmacy curriculum. The appropriate course content was organized in a modular format that began with the general concepts of drug product administration, preparation, stability, and performance and then specifically applied these concepts to a variety of non-sterile dosage forms.
Findings: Student performance was assessed through several cumulative exams and lab practicals. Mean performance on these assessments was at a level generally considered to be adequate within the study institution. However, students performed better on the assessments having a lesser emphasis on physical pharmacy ($p < 0.05$) and a greater focus on basic skill development ($p < 0.05$). Student perceptions were evaluated using a survey instrument that had a useable response rate of 93%. Each course design element was utilized by a majority of respondents and was generally perceived as being beneficial to student learning.
Summary: The collected data indicate that the integrated course design facilitated the learning of applicable pharmaceutics-related topics and support the use of a number of different design elements. In addition, this study provides valuable insights for others providing professional-level pharmaceutics-related education and has helped guide our own course improvement efforts.

Background and purpose

The importance of pharmaceutics-related concepts to the practice of pharmacy has been well documented, particularly with regard to pharmaceutical calculations and pharmacy compounding.[1–10] The need to appropriately educate student pharmacists regarding these concepts is further highlighted by their inclusion within the current Accreditation Standards and Guidelines for the Professional Program in Pharmacy Leading to the Doctor of Pharmacy Degree,[11] Center for the Advancement of Pharmacy Education Educational Outcomes,[12] and North American Pharmacist Licensure Examination Competency Statements.[13] However, substantial debate still remains regarding how these concepts may be best incorporated into contemporary doctor of pharmacy (PharmD) curricula and best taught to current student pharmacists.[1,2,5,8–10] In an attempt to address some of these concerns, the current statuses of pharmaceutical calculations and pharmacy compounding education within US Colleges and Schools of Pharmacy have been characterized and assessed, respectively.[1,2] In addition, several faculties have recently evaluated and/or improved the quality of their own institution's pharmaceutics-related curricula through the development of new courses,[4,10] evaluation of skill measurement and

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Table 1
MWU-CPG's required pharmaceutics-related courses[a].

First Didactic Year			
Summer Quarter[b]	Fall Quarter[b]	Winter Quarter[b]	Spring Quarter[b]
Pharmaceutical Calculations (2 credit hours)	*Pharmaceutics I w/compounding lab (4 credit hours)*	*Pharmaceutics II w/compounding lab (4 credit hours)*	*Biopharmaceutics & Pharmacokinetics (4 credit hours)*
	Non-Sterile Products Portion	Sterile Products Portion	

[a] Each preceding course serves as a pre-requisite for the subsequent course.
[b] Each quarter is 10 weeks in length.

retention,[6,9] use of new technologies,[14,15] creation of new laboratory exercises,[3,8] comparison of different teaching and remediation strategies,[5,16] implementation of integrated assignments,[7] and contrasting of different exam question types.[17]

At Midwestern University College of Pharmacy-Glendale (MWU-CPG), pharmaceutics-related concepts are taught primarily through four required courses (*Pharmaceutical Calculations*, two credit hours; *Pharmaceutics I and II with pharmacy compounding lab*, four credit hours each; and *Biopharmaceutics and Pharmacokinetics*, four credit hours) that take place throughout the college's first didactic year; each preceding course also serves as a pre-requisite for the subsequent course (Table 1). These courses also take place within the context of an accelerated, three-year PharmD curriculum implemented through a year-round, four-quarter system (10 weeks each) starting in the summer. Immediately upon arriving at MWU-CPG in 2002, the current pharmaceutics faculties designed a pharmaceutics course sequence (*Pharmaceutics I and II*) that integrates the disciplines of physical pharmacy, dosage forms, pharmacy compounding, and pharmaceutical calculations that was founded on the belief that an integrated curricular design is necessary in helping students apply basic scientific concepts to patient care.[7] In relation, *Pharmaceutical Calculations* may be considered to be a traditional stand-alone course that prepares students for *Pharmaceutics I and II*, just as these courses prepare students for *Biopharmaceutics and Pharmacokinetics*, another traditional, stand-alone course.

This report describes the initial design and subsequent implementation and assessment of the non-sterile products portion of MWU-CPG's pharmaceutics course sequence amongst the Classes of 2013–2015. This particular portion of the course sequence consisted of the entire *Pharmaceutics I* course and the first two-thirds of the *Pharmaceutics II* course; the remaining one-third of the *Pharmaceutics II* course was dedicated to sterile products (Table 1). Each of the non-sterile and sterile products portions were also coordinated and taught by a different pharmaceutics faculty member based upon their relative expertise. The non-sterile products portion was specifically designed to facilitate the learning of applicable pharmaceutics-related concepts and was assessed by evaluating both student performance and perceptions. The long-term goal of this work is to further elucidate how such concepts may be best incorporated into contemporary PharmD curricula and be best taught to current student pharmacists.

Educational activity and setting

Pharmaceutics, which may be described as the study of drug delivery systems and/or drug products, is taught at both the graduate and professional levels. Graduate-level pharmaceutics education has traditionally focused upon a deep understanding of the fundamental scientific principles within disciplines such as physical pharmacy, biopharmaceutics, and pharmacokinetics along with an application of these principles to basic research. Alternatively, professional-level pharmaceutics education is generally believed to be most effective when providing an appropriate foundational understanding of such principles together with a relevant application to contemporary pharmacy practice.[7] In this spirit, the non-sterile products portion of MWU-CPG's pharmaceutics course sequence was designed to not only integrate the disciplines of physical pharmacy, dosage forms, pharmacy compounding, and pharmaceutical calculations, but to also include the respective topics the course coordinator/instructor deemed most relevant to a PharmD curriculum (Table 2, Appendices A and B). The inclusion of pharmaceutical calculations was also meant to serve as a continued review and

Table 2
Course learning objectives for the non-sterile products portion of MWU-CPG's pharmaceutics course sequence[a].

1. Select an optimal dosage form, formulation, and route of administration for a specific drug entity and patient with regard to efficacy, safety, and adherence
2. Describe the methods used to prepare, package, and store manufactured drug products
3. Calculate appropriate doses, drug concentrations and strengths, rates of administration, and quantities of drugs and excipients required to compound, dispense, and deliver drug products
4. Prepare, package, store, use, and dispose of repackaged or compounded drug products
5. Describe the pharmaceutics principles important for the administration, preparation, stability, and performance of drug products
6. Apply pharmacy laws and good compounding practices with regard to prescription interpretation and documentation, dispensing and compounding activities, and prescription labeling
7. Select and use appropriate references and literature for the retrieval and interpretation of drug product information
8. Discuss the importance of drug product development and preparation to the practice of pharmacy and provision of patient care
9. Demonstrate professional characteristics such as patient-centered care, ethical decision-making, effective communication, teamwork, and the critical-thinking and problem-solving skills necessary for self-directed, life-long learning

[a] All course objectives were linked to the appropriate MWU-CPG Intended Educational Curricular Outcome.