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RESEARCH ARTICLE

Using drug information to bridge basic science with pharmacy practice

Cambrey Nguyen
Department of Pharmacy Practice, School of Pharmacy, University of Kansas, Kansas, United States

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Correspondence
Cambrey Nguyen
Department of Pharmacy Practice
University of Kansas
United States
cnguyen@ku.edu

Abstract

Background: Drug Information (DI) skills are essential to pharmacists and encompass information retrieval along with literature evaluation on drug characteristics, including foundational sciences. A novel approach was implemented using DI focused learning opportunities to educate first year learners about clinical relevance and integration of basic science concepts into pharmacist knowledge. **Methods:** A lecture introduced the integration by mapping sections of a drug's prescribing information to all courses in the University of Kansas School of Pharmacy curriculum. An innovative activity required students to use the knowledge obtained from concurrent P1 courses to determine the cause of death of a fictional patient. Other activities included answering drug availability questions on the clinical development process and presenting a research article. Assessment of learning was based on student performance. **Results:** From 2019 to 2021, the proportion of students who determined the cause of death ranged from 59-67%, and the mean scores for the drug development assignments were 94-95%. The median score was 8/10 for the rubric item discussing the relevance of the research article to basic science and/or pharmacy practice, and total scores for the presentation ranged from 80-98%. **Conclusion:** Based on the results, students demonstrated their understanding of the relationship between basic science and pharmacy practice.

Introduction

Curricular integration in pharmacy education is an essential component in providing a connection across multiple disciplines in the curriculum and allowing for coherent and relevant educational experiences for the student learner (Pearson *et al*., 2012). In addition, basic science concepts are the foundation of drug knowledge and in making appropriate recommendations for patient care in pharmacy practice. The Accreditation Council for Pharmacy Education (ACPE) standards 9, 10, and 15 focus on integrating learning with practice, integrating content and competencies across disciplines, and using teaching and learning techniques to promote integration, respectively (ACPE, 2015). In the literature, several pharmacy programmes developed activities to introduce the relevancy of basic science to pharmacy practice in the past decade. The learning opportunities included a common reading experience to apply basic science concepts to a patient with cancer, the development of a new fictional drug leaflet to educate pharmacists, a patient care project to connect science-based courses to practice, and an assignment on basic science and pharmacotherapeutic principles for the use of ophthalmic and otic, oncology, cardiology, and antidepressants drugs (Brown *et al*., 2009; Conway *et al*., 2010; Stewart *et al*., 2011; Black *et al*., 2012; Kolluru *et al*., 2012; Richardson *et al*., 2014; Kurup *et al*., 2017). All of these activities and projects promoted understanding of the integration through the application of knowledge as demonstrated by student performance on assignments or assessments. An area that has not been discussed is using drug information (DI) concepts to integrate basic science with pharmacy practice.

The University of Kansas Doctor of Pharmacy programme in the U.S. does not have an integrated curriculum at this time. One of the challenges observed in first-year students is the lack of understanding of how basic science concepts provide the foundation for their overall drug knowledge as a pharmacist. This challenge leads to potential barriers which can undermine student motivation, learning, and engagement in the first year of the programme and further on (Pittenger *et al.*, 2016). To address this challenge, activities were created in a first-year pharmacy skills laboratory course (PHAR 512) to promote curricular integration. The objective of this study was to implement DI focused activities to educate first year pharmacy students about the significance and clinical relevance of basic science concepts integral to a pharmacist's drug therapy knowledge.

Methods

Within the University of Kansas School of Pharmacy, there is some effort to align topics within basic science and pharmacy practice courses; however, the programme does not have a full integrated curriculum and basic science courses often do not align materials with current clinical practice. PHAR 512 is a pharmacy skills laboratory course that includes six weeks focused on introductory DI skills taught in the fall semester of the first year didactic programme. This course was selected for integration as it is the first course to expose students to DI skills. The first-year students are taught tertiary drug databases and primary resources to answer commonly asked questions in pharmacy settings such as the use of drugs in pregnancy and lactation, identifying tablets, uses of natural products, and checking drug-drug interactions. Additional concepts covered in the course include the drug development process and biomedical research. The other portion of the laboratory course focuses on basic science concepts covered in medicinal biochemistry (DNA, lipids, buffers).

In Fall 2018, two activities were developed by basic science faculty in collaboration with the DI faculty to pilot the integration using DI concepts and resources in the course. The activities were based on learning outcomes and objectives of understanding the concepts of the clinical drug development process, answering questions pertinent to a patient case, and learning how biomedical research supports patient care recommendations. These aspects allow learners to apply their knowledge of foundational sciences to clinical scenarios in answering drug questions from patients and healthcare professionals using DI resources and literature. A lab session on the drug development process was created, and students completed an assignment on pre-clinical (animal) research concepts and then answered DI questions about the different stages of human research. The students applied the knowledge through answering DI questions specifically on drug availability using primary resources such as clinicaltrials.gov, the FDA website, and the manufacturer's website. The second learning opportunity required students to present a pre-clinical, clinical, or practice-based research article in groups of five at the end of the semester. Evaluation of the pilot was based on the assessment of student learning through performance on the assignment and presentation. An unvalidated student perception questionnaire (Likert scale) administered through Qualtrics (Provo, UT) was developed to obtain feedback on the activities for future improvement. After the completion of the pilot, an additional innovative activity, Mystery in the Forensic Lab, was embedded in the pharmacy skills laboratory course in 2019 to enhance curricular integration.

Prior to the Mystery in the Forensic Lab activity, students received a lecture on curricular integration through a visual mapping of the sections within prescribing information (PI) of a drug to the basic science and pharmacy practice courses taught in the University of Kansas curriculum. This lecture is provided to students in the first week of pharmacy school to provide an understanding of the curricular requirements of the programme and the overall contribution to the pharmacist's knowledge of drugs. This lecture precedes an introduction into DI skills and resources and how they are utilised in pharmacy practice.

In week five of the lab, the Mystery in the Forensic Laboratory activity required students to utilise the knowledge obtained from concurrent P1 fall courses including Clinical Chemistry, Pharmacology, Pharmacy Calculations, and Medicinal Biochemistry while using DI resources to answer a series of questions to determine a fictional patient cause of death (Table I).

The scenario includes a forensic laboratory requesting a consult from a pharmacist for a case they suspect the death may be related to pharmaceutical products. The patient's case included a list of concomitant drugs (prescription, over-the-counter, and natural products), medical history, lab values, toxicology results, physical signs and symptoms, and a timeline of the patient's activities leading up to the death including when prescriptions were picked up. The students worked in pairs or groups to answer questions about indications of drugs (Pharmacology), drug identification using physical characteristics, uses of natural products, calculating milliequivalents of an over-the-counter supplement (Pharmacy Calculations), and using chemical groups in chemical structures to identify the name of drugs (Medicinal Biochemistry). After answering all the questions, each student provided a written rationale for the cause of death of the fictional patient based on the information they obtained, accounting for lab values (Clinical Chemistry), drug interactions, and adherence to prescription medications. In weeks 9, 11, and 12, the students participated in the drug development lab and presented over journal articles in which they were required to discuss the relevance of the study to concepts of basic science and/or pharmacy practice.

Table I: ***Questions featured in mystery in the forensic lab activity***

Types of questions	
Natural products	Identify the uses for the natural products the patient was taking.
Chemical structures	An HPLC chemical analysis was performed because drugs were crushed and required identification through chemical structures.
Prescription drugs	Find indications or use of the drugs provided using tertiary databases.
Drug identification	Several drugs were found in a pillbox and required identification by markings on the tablets/capsules.
Toxicology test	The forensic lab provided a toxicology test to verify the use of any illicit substances and students determined whether these substances may interact with drugs.
Over the counter supplement	A potassium supplement was provided, and students were required to calculate milligrams of the product to milliequivalents.

The resources required to create these learning opportunities were minimal. Printouts of the patient case for Mystery in the Forensic lab activity were provided in the first year of implementation, and students were asked to share nine copies of the materials within each lab session. The printouts did not require additional cost. The estimated time spent on the development of the activity and discussion with other basic science faculty took several weeks over the summer.

Starting in 2019, student learning was assessed through grades on the assignments and presentations. A separate student survey was no longer administered as the activities were well blended throughout the course and any changes made to the activities were based on the university end of semester student evaluations. Descriptive statistics were used to represent the scores and student perception ratings in the Likert survey conducted in 2018. The University of Kansas Human Research Protection Programme, provided IRB approval.

Results

A total of 499 students enrolled in the laboratory course from 2018 to 2021 participated in the activities. For the pilot (n=146) conducted in 2018, the mean scores for the drug development lab and presentations were 98% and 95%, respectively. There were 66/146 students who filled out the perception questionnaire, and the majority of students agreed (50/66) the focused learning opportunities helped to connect concepts obtained throughout the course. The student performance and responses indicated the content and assignments in PHAR 512 helped integrate basic science concepts into pharmacy practice using DI concepts. Based on the positive feedback and the performance of the pilot, the innovation was further expanded with additional assessments with student feedback incorporated in 2019. The results for the assessments for classes from 2019 (n=120), 2020 (n=126), and 2021 (n=107) are presented in Table II.

Table II: Assessment of student performance on activities related to integration in PHAR 512

Assessment type	**2019**	**2020**[#]	**2021**
Mystery in the forensic laboratory: No. of students who correctly determined the cause of death	71/120 (59%)	56/84 (67%)[‡]	66/107 (62%)
Drug development laboratory: Pre-laboratory assignment and DI questions	95% (mean)	96% (mean)	94% (mean)
†Journal article presentations: Grading rubric section on relevancy of journal article to basic science and pharmacy practice (0-10 points)	8/10 (median score)	8/10 (median score)	8/10 (median score)

‡Due to a system error in the online learning platform, the submitted responses of 42/126 students did not display;
†Overall scores of the presentations ranged from 80%-98%;
#Remote teaching conducted using Zoom and other online platforms due to COVID-19 restrictions

Overall, the data show that innovation has an impact on student understanding of integration. Student performance was similar across the years and activities; however, in 2020, an error in the Softchalk (Richmond, VA) online learning platform did not record the responses of 42/126 students in the system for the Mystery in the Forensic lab activity so the number of students who correctly determined the cause of death may have been higher. In Fall 2020, learning was conducted remotely via Zoom or through other online mechanisms due to COVID-19 restrictions at the university. No differences were seen in performance for in-person or remote learning for these activities.

Discussion

Using drug information as the bridge for curricular integration is novel as it has not been highlighted in the literature. Since the inception of this approach, learners have applied their knowledge of basic science concepts to patient care and developed DI skills through retrieval of drug information and literature review in the pharmacy skills laboratory course, PHAR 512. The Mystery in the Forensic laboratory activity along with other activities, promoted an understanding of curricular integration which was similar to efforts in other programmes (Brown *et al*., 2009; Conway *et al*., 2010; Stewart *et al*., 2011; Black *et al*., 2012; Kolluru *et al*., 2012; Richardson *et al*., 2014; Kurup *et al*., 2017).

Furthermore, the integration has provided opportunities in the first year of the pharmacy programme to use tertiary databases and primary resources to answer commonly asked DI questions, read a biomedical research article, and present to an audience over a journal article using PowerPoint. These areas address multiple learning competencies set by pharmacy entities while requiring an early development of DI skills and promoting an understanding of the significance of these skills in pharmacy settings (Pearson *et al*., 2012; Medina *et al*., 2013; Pittenger *et al*., 2016). An important reason for the implementation of the curricular integration in the first year was to prepare students for the use of DI skills in future courses and for the experiential rotation set in the summer of the first year. Additionally, pharmacotherapy series do not begin until the Spring semester of the first year within the programme; therefore, the Mystery in the Forensic lab activity allowed for early exposure to patient cases using concomitant medications, medical history, and lab values and offers preparation for additional patient cases featured in pharmacotherapy sequences in the following semesters.

In addition to early exposure of DI skills and patient cases, the students were introduced to activities that focus on the student's ability to not only recall, identify or interpret information but to apply, analyse, and create. The curricular integration was evaluated through multiple mechanisms that allowed students to demonstrate mastery of the content through active learning. This aspect has been emphasised as a pedagogical structure for integration to facilitate the importance of the student's ability to synthesise and apply knowledge to complex patient care situations (Pearson *et al*., 2012; Ratka *et al*., 2012; Howard *et al*., 2015; Medina, 2017). Furthermore, the different types of instructional assessments (i.e., answering short answer questions, working on a patient case) promote a higher order of learning based on Bloom's taxonomy (Seddon, 2015). The format of these activities, in combination with the curricular integration, facilitates more meaningful learning opportunities in basic science and pharmacy practice courses and in the experiential setting where they can apply knowledge to real world situations.

This approach in curricular integration has not only helped the first-year students, but the basic science faculty to recognise the utility of DI skills in any pharmacy practice setting through collaboration on the Mystery in the Forensic Lab activity. Moreover, the faculty were able to see the types of questions pharmacists receive regarding the characteristics of drugs, the resources that can be used to find drug information, and the complexity of a patient's medication history including over-the-counter and natural products.

Limitations

A limitation of this study was not having a historical comparison prior to the implementation of the integration. The University of Kansas School of Pharmacy curriculum has made significant changes to the content and topics in the laboratory setting within the past five years; therefore, it was difficult to obtain data on student performance for comparison. Although there was a demonstration of an understanding of how basic science concepts can be utilised in pharmacy practice, there has not been an evaluation of the performance of the students exposed to these activities as practising pharmacists. Future expansion of these efforts may address these limitations by collecting additional data through implementation in the second and third year within the curriculum and assessment by other faculty across disciplines. In addition, gathering perceptions from preceptors, alumni, and graduates about the importance of the integration may provide insight into reveal areas that students may need additional focus or reinforcement through curricular integration. These aspects allow for measurement of the impact on a curricular level on learning outcomes of the integration. Additionally, although the student perception questionnaire was only utilised to obtain feedback regarding the activities in 2018, the questionnaire was not validated.

Conclusion

Since the inception of this innovation, students have been able to demonstrate their drug information skills and knowledge of how basic science concepts are used in pharmacy practice at the end of the fall semester based on their performance and ability to discuss the concepts they have learned during the presentations.

The success of these activities over the years inspires further expansion throughout the curriculum and obtains longitudinal data on the impact of the approach of using drug information concepts to foster curricular integration.

Conflict of interest

The authors declare no conflict of interest.

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