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INSTRUCTIONAL DESIGN AND ASSESSMENT

Pharmacy Students' Application of Knowledge From the Classroom to Introductory Pharmacy Practice Experiences

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Objective. To determine whether and how pharmacy students used knowledge learned in the classroom during their introductory pharmacy practice experiences (IPPEs) in community and hospital settings.

Design. To reinforce course concepts and make connections between coursework and practice, students documented examples of how knowledge from first-year courses was used in IPPEs.

Assessment. Data submitted were categorized by classroom-based pharmacy course, including the frequency with which each course was cited. For community practice experiences, most student examples of knowledge application related to the self-care therapeutics course, pharmacy practice laboratory course, and dose form/compounding laboratory courses. Hospital IPPE examples were most frequently based on the pharmaceutical calculations course, physiology/pathophysiology course, medicinal chemistry course, and pharmacy practice laboratory course.

Conclusion. All prior classroom-based pharmacy courses were cited by students as being useful during IPPEs, although some were more frequently cited than others. This activity provided useful programmatic assessment data.

Keywords: introductory pharmacy practice experience, experiential education, assessment, pharmacy education

INTRODUCTION

Comprising approximately one-third of the pharmacy curriculum, experiential learning courses represent an important component of each student pharmacist's education. In addition to providing opportunities to apply knowledge, skills, and behaviors, these experiences should also allow students to make connections between classroom coursework and the practice environment. The Accreditation Council for Pharmacy Education standards state that "pharmacy practice experiences must integrate, apply, reinforce and advance the knowledge, skills, attitudes and values developed through the other components of the curriculum."[1] Further, Appendix C of the standards, which provides additional guidance on pharmacy practice experiences, states that pharmacy practice experiences should be "carefully coordinated with other components of the curriculum."[1]

Reinforcing and integrating classroom course content, as well as creating opportunities for explicit connections between classroom coursework and practice experiences, may be especially beneficial or necessary for students participating in introductory pharmacy practice experiences (IPPEs) because these experiences are dispersed throughout the classroom course curriculum and provide a natural opportunity to make linkages (vs being a capstone experience at the conclusion of the curriculum); and because students at earlier stages in the curriculum may have a limited view of how coursework and practice experiences are connected. For example, as students progress through the curriculum, they often have less difficulty understanding how they will apply content from a therapeutics course to the practice of pharmacy, but may have more difficulty understanding how courses earlier in the curriculum (eg, foundation courses in pharmaceutical sciences) have relevance or relate to pharmacy practice.

Other educators have described the difficulty that students have in applying pharmaceutical science concepts to the patient care environment.[2,3] Interventions to help facilitate this connection have been successfully used within the classroom environment. Brown and colleagues described a curricular-wide patient care project that linked 8 primarily basic-science courses with assignments facilitated through a volunteer patient.[2] Another study looked at an integrated "crossover" assignment between a pharmaceutics and pharmacy practice course to emphasize the relevance of basic science in practice.[3]

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Recognizing the potential for students to underestimate the value of foundation courses, a goal in designing the University of Wyoming IPPE program was to facilitate connections between classroom and experiential learning occurring early in the curriculum. This was accomplished by designing an activity and giving students the responsibility for documenting explicit connections between pharmacy foundation courses and practice.

Other colleges and schools of pharmacy have found value in creating IPPE assignments that had purposeful links between classroom course content and the practice experience environment or in having students reflect on how classroom learning related to their IPPEs.[4,5] One school created case-based "learning bridge" assignments that IPPE students completed with preceptor guidance while on a practice experience.[4] These assignments were designed to reinforce classroom course content for students as well as make preceptors more aware of the curriculum.[4] As part of another study, investigators had IPPE students reflect on how classroom instruction received in specific courses prepared them for practice experience activities and then documented each course the students mentioned.[5] Another pharmacy program had IPPE students document achievement of CAPE competencies throughout their practice experiences.[6] While a list of classroom courses cited as a source of knowledge or preparation for introductory practice experiences has been published,[5] the actual context for how classroom coursework is used by pharmacy students has not been described.

This paper will discuss an IPPE assignment that required students to document how classroom course content had been used in the practice experience environment. The purpose of this study was to describe how students used classroom course content in IPPEs and determine if there was a difference between the content used in community and hospital practice experiences. A secondary purpose was to review student responses and provide this assessment data to the school and first-year (P1) instructors.

DESIGN

A major component of the IPPE sequence at the University of Wyoming is the two 4-week practice experiences in hospital and community pharmacy practice, respectively. Both IPPEs are completed in the summer following the P1 year for a total of 320 contact hours (160 hours each in hospital and community pharmacy practice). The IPPEs at the University of Wyoming have been in place since summer 2007.

The final grade for each IPPE was determined by combining the student's grade on the evaluation submitted by the site preceptor using a standardized evaluation form (70%), and a series of graded assignments submitted to the school's experiential faculty members (30%). These assignments given by the school were in addition to any assignments provided by the preceptor. The purpose of the school-initiated assignments was to motivate students to play a more active role in their learning and build direct links between prior coursework and experiences during IPPEs. Completed assignments were submitted to the experiential director/course instructor for grading via an online course management tool. Assignment feedback and grades were communicated back to the student using the same online course management tool. While this study focused on the classroom/practice experience linking assignment, Table 1 provides a list of all assignments completed during the IPPEs in community and hospital practice and the corresponding percent of overall grade.

First-year pharmacy students took 9 classroom-based courses, 2 laboratory courses, and a 1-credit-hour survey course exploring the various roles pharmacists have in the healthcare system (Table 2). Students also participated in their first IPPE, which involved shadowing a P4 student on 3 different practice experiences and undergoing orientation for their first practice experiences in community and hospital practice.

During their subsequent community and hospital IPPEs, students were given an assignment that asked them to make explicit connections between the first year classroom/laboratory courses and situations encountered during their practice experiences. During each practice experience, IPPE students had to provide examples of these connections between 6 of the P1 courses and IPPE activities. (The P1 IPPE course and the "Role of the Pharmacist in Health Care" course were excluded from the assignment because the content of these courses is primarily experiential or informational.) Students were instructed to be specific, provide the context of the clinical situation or event that occurred during the practice experience, what they learned in the classroom course, and how it related to the practice experience activity described. Because the experiential faculty members grading the assignment did not necessarily know the exact content covered in every course the students had completed, students were advised to incorporate information about relevant course content in their examples. Vague examples such as, "I calculated a creatinine clearance" were not sufficient because the clinical situation surrounding the calculation and how it related to concepts learned in the classroom were not discussed.

ASSESSMENT AND EVALUATION

An assessment was designed to determine how well students connected or linked their classroom course instruction with practice experiences. An initial assessment

Table 1. Assignments for Community and Hospital Practice Experiences

Completed During Both IPPEs (Percent of Grade)	
Personal Learning Plan (5%)	The purpose is to facilitate a dialogue between the preceptor and student and for the student to be an active participant in his/her practice experience education. Students document goals based on what they want to develop or accomplish during the practice experience and send this to the preceptor 2 weeks prior to the start of the practice experience. Once on-site, the student and preceptor meet to review the goals, discuss other learning opportunities, expectations and special projects the preceptor wants the student to accomplish, and establish a learning plan for the practice experience.
Classroom/Practice Experience Linking Assignment (5%)	Each course completed in the first year (P1) curriculum is listed. Students choose at least 6 courses and provide evidence demonstrating how specific classroom course content was used during the practice experience. See additional description in manuscript.
Final Reflection (5%)	After completing each practice experience, students respond to 5 reflective questions relating to: (1) their perceived strengths; (2) their greatest insights; (3) areas requiring further development; (4) what they wish they had known or skills needed before starting the practice experience; (5) when returning to school, what are they motivated to learn or learn more about?
Completed During Community IPPE Only	
OTC Assignment (15%)	Students complete the self-care therapeutics course prior to the start of IPPEs. To reinforce the knowledge gained from this initial therapeutics course, students spend at least 4 hours per week in the OTC section of the pharmacy. The QuEST/SCHOLAR[7] process is a method of patient assessment/triage taught throughout the course; therefore, students document at least one patient encounter in which they assisted a patient with a self-care question or concern.
Completed During Hospital IPPE Only	
Medical Chart Review / SOAP (7.5%)	Students complete the pharmacy practice lab course prior to the start of IPPEs and are introduced to charts, medication histories, the patient work up process and basic SOAP note documentation. The purpose of this assignment is to practice aspects of the course by ensuring that students worked with a real patient chart/electronic medical record and gain familiarity with how to find information important to pharmacists in providing patient care. A secondary purpose is to review and practice SOAP note documentation with a real patient case.
Presentation at Practice Experience Site (7.5%)	To help develop written and oral communication skills, students provide a brief presentation or in-service during the hospital practice experience. Preceptors have flexibility in choosing topics of benefit for hospital/pharmacy staff. Presentations are 10-15 minutes long with a required handout.

from the first year of practice experiences (2007) was undertaken in 2008.[9] This analysis was then augmented with data from practice experiences occurring in 2010 and 2011. All student submissions were reviewed by the course instructor and categorized by classroom course. Because students were not required to document examples for every P1 course, the frequency with which students provided evidence for each course was determined. Chi-square analysis was used to determine if there was a difference in the frequency of reported course content between hospital and community IPPEs. To provide feedback and information regarding how students used content from each course, a compilation of documented examples from each course was forwarded to the appropriate P1 instructors, including those instructors who were not part of the school (eg, biochemistry and integrative physiology instructors).

Students met the expectations of the assignment and the average score for each year's assignments was over

Table 2. Classroom and Laboratory Courses Taken by First-Year Pharmacy Students Prior to Beginning Their Introductory Pharmacy Practice Experiences

Semester	Course
Fall	Principles of Biochemistry
	Integrated Physiology
	Dose Form Design
	Dose Form Design Laboratory
	Pharmaceutical Calculations
	Role of the Pharmacist in Health Care[a]
Spring	Pathophysiology
	Biopharmaceutics/Pharmacokinetics
	Medicinal Chemistry I
	Self-Care (OTC) Therapeutics
	Drug Use Process[b]
	Pharmacy Practice Laboratory
	IPPE—Introductory Pharmacy Practicum

Abbreviations: OTC = over the counter; IPPE = introductory pharmacy practice experience.

[a] "Provides an overview and survey of the scope of pharmacy, including educational and licensing requirements; career opportunities, pharmacy organizations and regulatory agencies, and historical evolution."[8]

[b] "Focuses on how and why people use pharmaceuticals; people as patients; illness and wellness behavior; drug misadventuring, and appropriate intervention strategies."[8]

90%. Some students chose to provide several examples for each course and a few provided more than the 6 required examples. In reviewing data from 2007, 2010, and 2011, (years 1, 4, and 5, respectively) students provided over 1600 examples denoting how course concepts from first-year classroom courses were used during community and hospital IPPEs. Table 3 delineates the examples provided for the community IPPE. In this practice environment, nearly every student gave an example relating to a self-care (nonprescription) therapeutics course, pharmacy practice laboratory course, and dose form design/compounding laboratory course. Students were less likely to provide examples for physiology/pathophysiology, drug use process, biopharmaceutics/pharmacokinetics, and biochemistry.

Classroom course connection examples relating to hospital IPPEs are provided in Table 4. Students, on average, provided the greatest number of examples for pharmaceutical calculations, physiology/pathophysiology, medicinal chemistry, and pharmacy practice laboratory. Similar to the community practice experience, students provided fewer examples for drug use process and biochemistry. In contrast to the community practice experience where self-care (nonprescription) therapeutics was the example most frequently used, self-care represented only 6% of the examples provided for hospital practice experiences. The pharmacy practice laboratory course and pharmaceutical calculations course were the 2 courses for which the most examples were cited between both practice experiences (Table 5).

Chi-square analysis was used to determine if there was a difference in the frequency of reported course content between hospital and community IPPEs. There was a significant difference in the classroom coursework used and documented by students participating in community versus hospital IPPEs $p < 0.001$). When analyzing the basic science courses alone, there was also a difference in the courses documented during community vs hospital IPPEs ($p < 0.001$). The difference persisted when analyzing only clinical/social science courses ($p < 0.001$).

In addition to reviewing frequency data, the content of responses was also analyzed for 1 pharmacy practice

Table 3. Number of Documented Examples Linking Knowledge Learned in First-Year Pharmacy Classroom Courses to Community Introductory Pharmacy Practice Experiences

Course	Frequency With Which Course Was Documented by Students, No.			Total Responses, No. (%)	Percentage of All Respondents Who Cited This Course
	2011 (44 students)	2010 (44 students)	2007 (46 students)		
Self-Care[a]	44	44	45	133 (16.2)	99.3
Pharmacy Practice Laboratory	44	43	44	131 (15.9)	97.8
Dose Form Design & Laboratory	43	36	45	124 (15.1)	92.5
Pharmaceutical Calculations	38	36	40	114 (13.9)	85.1
Medicinal Chemistry	38	30	40	108 (13.1)	80.6
Physiology/Pathophysiology	18	26	27	71 (8.6)	53.0
Drug Use Process	21	22	21	64 (7.8)	47.8
Biopharmaceutics/Pharmacokinetics	17	23	19	59 (7.2)	44.0
Biochemistry	5	6	7	18 (2.2)	13.4

[a] Self-treatment with over-the-counter (nonprescription) drugs and products.

Table 4. Documented Examples Linking Knowledge Learned in First-Year Pharmacy Classroom Courses to Hospital Introductory Pharmacy Practice Experiences

Course	Frequency With Which Course Was Documented by Students, No.			Total, No. (%)	Percentage of All Respondents Who Cited This Course
	2011 (46 students)	2010 (43 students)	2007 (46 students)		
Pharmaceutical Calculations	42	38	41	121 (14.8)	89.6
Physiology/Pathophysiology	41	38	40	119 (14.5)	88.2
Medicinal Chemistry	44	36	39	119 (14.5)	88.2
Pharmacy Practice Lab	43	40	34	117 (14.3)	86.7
Biopharmaceutics/Pharmacokinetics	39	33	38	110 (13.4)	81.5
Dose Form Design/Lab	36	29	40	105 (12.8)	77.8
Drug Use Process	14	22	14	50 (6.1)	37.0
Self-Care[a]	11	18	20	49 (6.0)	36.3
Biochemistry	8	6	14	28 (3.4)	20.7

[a] Self-treatment with over-the-counter (nonprescription) drugs and products.

course and 1 pharmaceutical science course for 2011 practice experiences. In examples relating to the self-care therapeutics (nonprescription) course, students addressed over 30 different health conditions (eg, allergic rhinitis, pain). In reference to the medicinal chemistry course, students discussed 16 different therapeutic categories (eg, antibiotics, anticoagulants), as well as general topics (eg, drug interactions, mechanism of action, intravenous compatibility).

Students' responses varied. A representative sample student response for the biopharmacetuics/pharmacokinetics that met the criteria for the assignment and was given full credit is provided in Appendix 1.

While obtaining student perceptions can be useful, for this particular assignment it was not a primary focus. However, student feedback was obtained in 2010 for all assignments completed during community and hospital IPPEs. Questions relating to the assignment are shown in Table 6. Ninety-one percent of responding students agreed that completing this assignment made them aware of how P1 coursework was applicable to pharmacy practice; 86% believed that all practice experience assignments were relevant to their education.

DISCUSSION

The purpose of this study was to determine whether and how students applied knowledge they learned in the classroom during their IPPEs and if there was a difference between the courses students credited with providing knowledge used in community and hospital practice experiences. In addition, responses were intended to provide assessment data for the school and P1 instructors.

Students were able to articulate how they used prior classroom course concepts in IPPEs. Despite the instructor's perception and concern that students may have been taking their knowledge learned in the classroom for granted, when asked, they were able to provide solid examples and link their classroom coursework with both the community and hospital practice environments. While students were more apt to provide examples of applied

Table 5. Summary of Examples Documenting Application of Course Knowledge in Community and Hospital Introductory Pharmacy Practice Experiences

Course	Community (134 Students)	Hospital (135 Students)	Total, No. (%)
Pharmacy Practice Lab	131	117	248 (15.1)
Pharmaceutical Calculations	114	121	235 (14.3)
Dose Form Design/Lab	124	105	229 (14.0)
Medicinal Chemistry	108	119	227 (13.8)
Physiology/Pathophysiology	71	119	190 (11.6)
Self-Care (OTC)	133	49	182 (11.1)
Biopharmaceutics/Pharmacokinetics	59	110	169 (10.3)
Drug Use Process	64	50	114 (7.0)
Biochemistry	18	28	46 (2.8)
Total	822	818	1640 (100.0)

Table 6. Student Perceptions Relating to the Classroom/Practice Experience Linking Assignment[a]

Question	Strongly Agree (%)	Agree (%)	Neutral (%)	Disagree (%)	Strongly Disagree (%)	Response,[b] Mean (SD)
By completing the Classroom/Practice Experience Linking Assignment, I am aware of how coursework completed in my first year is applicable to the pharmacy practice setting.	18	73	5	5	0	2.0 (0.7)
The assignments supplemented my patient care experiences.	14	73	14	0	0	2.0 (0.5)
The assignments that I completed were relevant for my education as a student pharmacist.	18	77	5	0	0	1.9 (0.5)

[a] Scale: 1 = Strongly Agree, 5 = Strongly Disagree; Percentages may not add to 100 due to rounding.
[b] Percent of students from 2010 completing questionnaire = 51%; N = 22

knowledge from some courses more than others, examples were generally distributed among all course types, demonstrating that students were using all prior coursework in the practice environment. There was a significant difference between the classroom course examples given for the hospital and community IPPEs.

Not surprisingly, students were able to make the most connections with the self-care (nonprescription) course, pharmacy practice laboratory course, and dose form design/ laboratory course while completing their community pharmacy practice experience. The community practice environment is rich with opportunities for pharmacists and student pharmacists to assist patients with self-care needs. Student examples included a variety of health conditions including allergic rhinitis, fungal infections, sunburn, musculoskeletal pain, and pediatric dosing recommendations. It is also intuitive that students were able to easily document content examples from the pharmacy practice laboratory as this course provided practical knowledge about the actual mechanics of filling prescriptions, legal considerations, and learning opportunities to assist patients with targeted health conditions like diabetes, asthma, and hypertension. In the state of Wyoming, pharmacy interns can transfer prescriptions, so many students talked about how learning to do this in the pharmacy practice laboratory course helped them complete this activity during their practice experience. Other students talked about being able to read and interpret prescriptions and having the baseline drug knowledge to successfully fill prescriptions. Many of the examples related to the dose form design course described the students' abilities to compound various products in the community pharmacy as a result of what they had learned and practiced in the laboratory component of the course.

One of the most striking findings of this study related to the medicinal chemistry course. The drug knowledge learned in the medicinal chemistry course appeared to be instrumental in helping students counsel patients and recognize drugs and drug classes. In contrast, it is unusual to find students at the end of the curriculum who would single out medicinal chemistry as a key component used in providing patient care. At the end of their education, much of pharmacy students' drug knowledge is integrated from the array of courses taken, with therapeutics courses serving as the primary vehicle to integrate this knowledge. Therefore, IPPE students' reliance on course concepts taught in medicinal chemistry to help them remember important counseling points for certain antibiotics, for example, was enlightening. The students' ability to use and recognize the value of this course content may also be attributable to the teaching techniques used in the course.

In the hospital environment, over 80% of students provided examples of using knowledge gained from their pharmaceutical calculations, physiology/pathophysiology, medicinal chemistry, pharmacy practice laboratory, and biopharmaceutics/pharmacokinetics courses. On hospital practice experiences, students were frequently involved in calculating drug dosages and monitoring drug therapy, which have direct applications to calculations and biopharmaceutics/pharmacokinetics courses. Examples of using knowledge from physiology/pathophysiology courses were more often cited for hospital than community practice experiences, which likely correlates with the acute presentation of a variety of diseases seen in that IPPE. In the pharmacy practice laboratory course, students have a session on intravenous preparation, and IPPE students often cited using the intravenous compounding skills learned in that course during their hospital practice experience.

Similar to findings described by Wuller,[5] these data are useful from an assessment perspective by demonstrating that students are able to draw upon classroom coursework in the experiential environment and that they are prepared

to encounter situations presented in community and hospital pharmacy practice environments. Assignment data also provided evidence that the school is meeting accreditation standards by having pharmacy practice experiences that are coordinated with and help reinforce classroom-based curricular components. A content analysis of the examples provided for the self-care therapeutics course found that students are being exposed to and assisting patients with a variety of health conditions. In addition, learning how students use course concepts in the introductory practice experience environment can be useful to P1 course instructors. This information may be especially helpful because courses taught earlier in the curriculum may get less feedback on exit surveys at the end of the curriculum because students may remember fewer specifics from the courses or overlook how foundational content contributed to their current knowledge base.

The classroom/practice experience linking assignment was relatively easy to implement and grade. Pharmacy class sizes at the University of Wyoming are small (52 students/class), so the grading process would be a greater burden for colleges and schools with larger class sizes. Collating student response data was the most time-consuming process because it necessitated copying and pasting from each student submission. By sampling data at 3 points in time, this study confirmed that students are documenting content from a variety of P1 courses. Therefore, determining the frequency with which students use knowledge learned in each P1 course on their IPPEs will not be done on an annual basis. The assignment itself, however, will be continued annually because it is perceived to be valuable for students, P1 instructors, and the school's assessment committee. A more efficient method of capturing and sharing examples of student application of knowledge learned with P1 course instructors is being developed using E*Value (Advanced Informatics, Minneapolis, MN), the school's practice experience management system.

CONCLUSIONS

As part of their community and hospital IPPEs, P1 pharmacy students were able to apply knowledge previously learned in the classroom and recognize this connection. Challenging students to think about and provide specific examples of knowledge application made the connections more explicit. It also allowed students to see the relevance of the classroom portion of their education and reinforced how foundational course concepts are directly applicable to pharmacy practice. An exercise such as the one described also can be a useful component in a pharmacy college or school's assessment program.

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Appendix 1. A representative sample student response for the biopharmacetuics/pharmacokinetics, which met the criteria for the assignment and was given full credit.

"During my rotation at XXX Hospital I had the opportunity to apply Biopharmaceutics and Pharmacokinetics to many aspects of the job. On a daily basis I would calculate the creatinine clearance for each patient in the hospital as we had been taught during Biopharmaceutics. For example, one female patient weighed 84.5kg, was 66 inches tall, and had a serum creatinine of 0.9. Using the Cockcroft-Gault equation, [(140-Age)(Weight in KG)/(72xSrCr)](0.85), and taking into account her ideal body weight as well as adjusted body weight, I found this particular patient's creatinine clearance to be 58ml/min. Not only did I have the chance to monitor patients' renal function, but I also had the opportunity to dose patients appropriately in accordance with their renal function. I had a clear understanding of the importance of this because biopharmaceutics really drilled into us how the kidneys affect the bioavailability of certain drugs."