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INNOVATIONS IN TEACHING

Learning Across the Curriculum: Connecting the Pharmaceutical Sciences to Practice in the First Professional Year

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Objectives. To facilitate the student's ability to make the connection of the core foundational basic science courses to the practice of pharmacy.

Design. In 2000, 10 faculty members from basic science and practice courses created and implemented an integrated Patient Care Project for which students chose a volunteer patient and completed 15 different assignments

Assessment. Evidence of student learning, such as grades and reflective comments along with collected evaluative data, indicated an enhancement in students' perceived understanding of the connection between basic science and patient care.

Conclusion. The Patient Care Project provided students an opportunity to use knowledge gained in their first-year foundational courses to the care of a patient, solidifying their understanding of the connection between basic science and patient care.

Keywords: curriculum, basic sciences, pharmacy practice, capstone experience

INTRODUCTION

As health care educators, our goal is building a foundational educational framework that supports our students in becoming health care practitioners. As noted in Accreditation Council on Pharmacy Education (ACPE) guidelines, the curriculum must prepare students to practice today and in the future as the profession of pharmacy continues to evolve by equipping them with knowledge based in "good science" that is "evidence-based, logical, convincing, honest, testable and systematic."[1] In order to meet the Accreditation Council on Pharmacy Education's standards, all pharmacy programs must include both basic science and pharmacy practice courses. However, as increased emphasis is placed on clinical course work, it becomes more difficult for students to connect the pharmaceutical sciences, which are the foundation of the practice of pharmacy, to patient care.

The difficulty is not unique to pharmacy education. As noted by Weatherall[2] and Prince et al,[3] medical school faculty members also have difficulty linking the pharmaceutical sciences to patient care. Examples also are cited in the nursing and dental literature.[4,5] The basic science curriculum gives students a sound foundation on which to develop the skills necessary for patient-centered pharmaceutical care. Some pharmacy faculty members believe that the basic science knowledge is what separates a pharmacist from a technician.[6] Pharmacy faculty members are engaged in innovative pedagogical approaches to help their students form the connection between pharmaceutical sciences and pharmacy practice. Examples include redesigning courses to incorporate pharmacy-related examples,[7] intellectual games,[8] computerized cases studies,[9] and structurally-based therapeutic evaluation.[10]

At the University of Cincinnati Winkle College of Pharmacy, faculty members identified the need for innovative and creative teaching methods to help struggling students gain an understanding of this critical connection. Out of many discussions and brainstorming sessions, the College's Patient Care Project was created to help foster the student's ability to connect first-year science-based courses to the art of practice. The Project involves 10 faculty members from 8 different courses that span the entire first year (P1). This collaborative, integrated project was designed around 1 student-selected volunteer patient. The student completes individual assignments within both science and pharmacy practice courses culminating with the creation and presentation of a comprehensive poster. This manuscript will describe the collaborative, yearlong project that began in the fall of 2000.

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The global learning objectives for the Patient Care Project are as follows:

- To advance the understanding of the relationship of the pharmaceutical sciences to pharmacy practice.
- To develop the student's ability to integrate knowledge gained from didactic course work to the care of a real patient.
- To promote the development of the student's ability to provide pharmaceutical care.
- To foster professionalism and professional behavior by promoting interactions between students and their patients, peers, mentors, and professors.
- To encourage scholarly activity early in the curriculum.
- To improve written and verbal communication skills across the curriculum.
- To cultivate each student into a lifelong learner.
- To build the ability of the student to empathize with the plight of others.

DESIGN

The Patient Care Project consisted of 15 individual assignments given in 8 courses over the first year of the curriculum (Appendix 1). Instructors were responsible for creating, grading, and evaluating assignments for their respective courses. Each assignment was designed to maintain patient confidentially and was compliant with health information privacy standards pursuant to the Health Insurance Portability and Accountability Act of 1996 (HIPAA). Overall responsibility for the Project was assigned to course directors of a yearlong course entitled Longitudinal Patient Care. The first critical step in this yearlong project occurred in the Longitudinal Patient Care course early in the fall quarter when students chose their volunteer patient, usually a family member or friend. Multiple interactions between the student and patient occurred over the next year as students applied and practiced a wide variety of skills taught in the core curriculum. Choosing a patient with whom the student had already established a relationship enhanced growth and learning, as all of the interactions occurred in the community, usually in the patient's home or the student's place of employment. This allowed students to learn without the pressure of performing for a grade. Once a patient was selected, students briefly interviewed them and completed the first assignment: documenting all disease states and current medications. Faculty members reviewed the completed volunteer patient forms submitted by the students and assigned a disease state and associated medication to each student. During this process, duplicative disease states were possible due to the prevalence of certain diseases in the general population. However, all efforts were made to avoid duplicative medication therapy. This step was necessary to individualize student learning by focusing all of the assignments on a single disease/medication combination due to the early placement of the project in the curriculum.

Once patient selection was completed, faculty members from the following courses gave students Patient Care Project assignments: Longitudinal Patient Care, Anatomy and Physiology, Fundamentals of Pharmacy Practice, and Biochemistry (Appendix 1). Each of the assignments reinforced and encouraged mastery of topics discussed in the course's core content as well as course-specific and overall Patient Care Project learning objectives. For example, in the Anatomy and Physiology course, students researched the physiological aspects of their patient's disease and wrote a critical review of related published articles. Students gained experience researching scientific literature and learned about the connection of anatomy and physiology to the principles, effectiveness, and toxicities associated with pharmacotherapy and improved their written communication skills.

During the winter quarter of the first year, students completed Patient Care Project assignments in Principles of Pharmacology, Pharmacy Communications, Longitudinal Patient Care, and Principles of Medicinal Chemistry. The assignment in the Principles of Pharmacology course highlighted the achievement of the dual goals of the Patient Care Project: reinforcement of core course components and connecting the pharmaceutical sciences to the care of the patient. Students wrote a review of the pharmacokinetic properties of the assigned drug, focusing on how these properties affected absorption, distribution, metabolism, and excretion, as well as dosage form. Upon completion, the student gained additional literature review skills, as well as an improved understanding of the integration of core course information. As part of the overall goal of the Patient Care Project, this assignment helped students improve their understanding of the connection of this science-based course, which focused on medication therapy, to the overall care of their patients.

In the spring quarter, both the Longitudinal Patient Care course and US Health Care Systems included Patient Care Project assignments. In the US Health Care Systems course, students interviewed their patient to discover various aspects about their patient's insurance coverage. The written report submitted by the students covered the patient's medical problems and medications, health insurance coverage including classification and advantages and disadvantages of the health plan from both the patient's and the health care provider's perspectives. This

project was intended to improve the students' ability to comprehend the complexities of the health insurance system from different points of view. At the same time, this assignment aided in the achievement of 2 overall Patient Care Project learning objectives: fostering professionalism and improving verbal communication skills by requiring the students to contact and interview their patient to ascertain the patient's personal health information.

The final assignment was an innovative capstone poster presentation in the winter of the P2 year. The 6-month delay between the last assignment in the spring quarter and this assignment gave students time to acquire additional skills and knowledge in both the pharmaceutical sciences and patient care. The students created a comprehensive but concise professional poster containing summaries of all 15 completed assignments. The poster also contained a thorough patient care plan expanding the students knowledge of the documentation of medication therapy management. The students orally presented their patient to Patient Care Project volunteer faculty members and community preceptors for evaluation in a professional poster format. This culminating presentation was intended to encompass all the global learning objectives of the Patient Care Project.

Assessing each of the individual course assignments and the capstone poster presentation was an important part of the Patient Care Project to measure achievement of the individual course and global learning objectives. Each assignment was designed to challenge students and help them evolve from the early stages of learning (ie, knowledge, comprehension, and application) to higher stages (ie, analysis, synthesis and evaluation according to Bloom's Taxonomy of Learning Behaviors (Table 1).[11] Since each Patient Care Project assignment was part of a specific course, the course coordinator had the responsibility for grading the assignment as well as determining the assessment tools needed to accurately evaluate each assignment as a measure of student performance (Appendix 1). For example, the course director for Principles of Pharmacology evaluated the Patient Care Project assignment using a defined set of standards that was applicable to all assignments within this course (Appendix 2). The evaluation of the capstone poster presentation, a key component of this yearlong project, utilized a specific comprehensive rubric to ensure consistent grading and immediate feedback. Besides evaluating general verbal and written presentation skills, the evaluator judged the student's ability to incorporate knowledge from each of the previously completed Patient Care Project assignments and on the creation of a thorough patient care plan. This rubric is available by request from the author . The majority of students performed as expected on the

Table 1. Mapping of Student Learning for the Patient Care Project Using Bloom's Taxonomy

Cognitive Domain	Course	Assignment	Description of How Assignment Meets Cognitive Learning "Objectives?"
Knowledge	Longitudinal Patient Care	Understanding the purpose and components of a basic Pharmaceutical Care Plan using the SOAP note format	Lecture provided that describes Pharmaceutical Care Plan and the documentation of such a plan using the SOAP note format
Comprehension	Longitudinal Patient Care	Comprehensive Final Exam	Students complete a final exam based on information contained within the course and their patient.
Application	Fundamentals of Pharmacy Practice	Create a Drug Interaction Report	Students apply skills acquired during course to creating a drug interaction report for their assigned patient/medication
Analysis	Pharmacy Communications	Patient Interview	Students must interview their patient and analyze the patient's beliefs on illness and medications to improve empathy
Synthesis	Longitudinal Patient Care	Capstone Poster Presentation	Students must synthesize all data from all Project assignments and create a poster presentation
Evaluation	Anatomy and Physiology	Critical Review Paper	Students must evaluate an article for strengths and weaknesses based foundational scientific principles

poster presentations (Table 2). Beginning with academic year 2005-2006, students were also asked to complete an anonymous evaluation in order to assess the entire year-long Patient Care Project. This survey contained 7 questions and used a 5-point Likert response scale (strongly agree to strongly disagree) and 2 open-ended questions.

ASSESSMENT

The results of students' evaluations of the Patient Care Project for 2006, 2007, and 2008 (response rate of 70%) can be found in Table 3 are most telling of the success of the Patient Care Project in meeting the global learning objectives. Students perceived that the Patient Care Project was successful in achieving the majority of the global objectives. Students perceived an increase in their ability to integrate knowledge gained from didactic course work with patient care (81%) and perceived an improvement in their ability to empathize with the plight of their patients (60%). More than 59% of the students agreed that the Patient Care Project fostered professionalism and professional behavior. Students also agreed 68% of the time with the first global objective: "this project helped me to understand the relationship of the pharmaceutical sciences to pharmacy practice." Fifty-five percent of students expressed a positive opinion regarding the global learning objective: "this project promoted the development of my ability to provide pharmaceutical care. For the final 2 global learning objectives, 48% of the students perceived an improvement in verbal and written communication skills. The remaining students were either undecided (25%) or disagreed (26%). The evaluation also contained 2 open-ended questions regarding the overall Patient Care Project, and more specifically, the capstone poster presentation. Out of the 182 completed survey instruments, 112 contained one or more comments. Eighty-two of the comments were positive, 46 were negative, and 27 were considered neutral. Examples are given below.

- "At first, I really didn't understand the relevance of writing papers in each class, but once I was finished, I felt that this project helped me to pull many different aspects of pharmaceutical care together. Even though I only focused on 1 disease state and 1 medication, being able to relate the biochemistry, medicinal chemistry, etc, information for this 1 entity was very educational."
- "While a good idea, this project didn't contribute to sufficient learning compared to the total time spent preparing for the project"

DISCUSSION

The success of this project rests with 3 key teaching methods: collaboration, capstone project, and applications of classroom concepts. The faculty members collaborating on this project included basic scientists, pharmacy practitioners, and administrative scientists with a variety of experiences and responsibilities. The range of academic experience was from full professors to assistant professors. This diverse collaboration was one of the major strengths of this project. The diversity, while a strength, was also a weakness in the project. Faculty members had to be actively engaged with the project from beginning to end to avoid duplication of assignments or content and to provide guidance to students.

Capstone projects are utilized in many health professions programs as a way to demonstrate competency. The innovation within the Patient Care Project was the scope and the depth of the project. Students had to synthesize data from 15 different assignments and apply this information to a patient in the community. The capstone poster presentation required students to present the patient's case in both written and oral formats. This requirement challenged students to show case the knowledge they had gained and their ability to present and answer questions associated with each assignment, thus demonstrating competency.

The results from this innovative capstone project survey were positive overall. Students perceived an improvement in both integration of knowledge to patient care (81%) and their ability to empathize with their patient (60%). This innovative project design allowed the students to focus on a specific patient for each assignment and provided an opportunity to apply the knowledge gained in the classroom to the care of a patient. Similar results are found in the pharmacy literature for students participating in such interactive learning experiences as

Table 2. Capstone Poster Grades[a] for Academic Years 2005-2006, 2006-2007 and 2007-2008 of the Patient Care Project

Longitudinal Patient Care	2005-2006	2006-2007	2007-2008
Spring quarter	64 students >90% 16 students:80-89%	72 students >90% 19 students:80-89% 2 students: 70-79%	72 students >90% 22 students: 80-89% 2 students: 70-79% 1 student <70%

[a]Poster presentation counted 40% of course grade.

Table 3. Pharmacy Students' Responses to a Final Voluntary Evaluation Survey Regarding the Patient Care Project

Results for Academic Years 2005, 2006 and 2007*	Strongly Agree to Agree (%)	Undecided (%)	Disagree to Strongly Disagree (%)
This project helped me to understand the relationship of the basic sciences to pharmacy practice (N=177)	68.4	17.5	14.1
This project promoted the development of my ability to provide pharmaceutical care. (N=178)	55.6	27	17.4
This project helped to develop my ability to integrate knowledge gained from didactic course work to the care of a real patient. (N=182)	81.3	9.9	8.8
This project fostered professionalism and professional behavior by promoting the interactions between my fellow students, my patient and my professors. (N=179)	59.7	21.4	18.9
This project allowed me to learn to empathize with the plight of my patient and others. (N=175)	60	21.1	18.9
Overall, the patient care project helped to improve my verbal communication skills. (N=177)	48.6	24.9	26.5
Overall, the patient care project helped to improve my written communication skills. (N=176)	48.9	25	26.1

*This survey is offered to the students in the winter quarter of the PY2 year, 1.5 years after the start of the Patient Care Project.

service-learning.[12] Fostering professionalism and professional behavior was another objective achieved by the Patient Care Project. This project started in the first quarter of the PY1 year, when students were in the first stages of becoming professional health care providers. As noted by Brehm et al, students must develop a wide range of characteristics, attitudes, and behaviors as a well as a lifelong commitment to professionalism.[13] The assignments within the Patient Care Project started the students on this journey by setting the expectations to include professional dress, language, and behavior, as well as adherence to laws and ethical standards. The Patient Care Project was designed to foster the students' perceived ability to make the connection of basic science to patient care. All faculty members involved, from both basic science and practice, worked together to provide assignments linking the core content of each involved course to the care of the volunteer patients. Other published opinions have expressed the need for this coordination as well. For example, Harrold states that both basic science and pharmacy practice faculty members must hold students accountable to analyze and apply basic science concepts in the provision of optimal patient care.[14] Students also felt that the Patient Care Project promoted their ability to provide pharmaceutical care (55%). This lower than expected positive response may be due to the placement of the Patient Care Project in the curriculum. At the end of the capstone poster presentation, students had completed only 2 of the 5 core therapeutics courses, which may have led to a decrease in their perception of their ability to provide comprehensive pharmaceutical care. The survey results for the final 2 global learning objectives, written and verbal communications skills, were lower than expected (48%). All of the assignments within the Project had a written component and it was the responsibility of the course coordinator to provide appropriate feedback to the students to encourage improvements. Students were also challenged to improve verbal communication skills in the final capstone poster presentation. This was the first time in the curriculum in which the students presented their work in this format, allowing them to experience an interactive professional forum. Poster sessions, by the nature of the presentation format, are not scripted and cannot be rehearsed. This situation gave students the opportunity to practice, improve, and build self-confidence.[15] Overall, the Patient Care Project was perceived by the students as meeting the 7 global objectives. This feedback from students helped faculty members understand the perceived extent and depth of student learning.

The successful teaching method of creating learning opportunities that required the student to apply classroom concepts involved a variety of unique assignments from scientific research papers to patient interviews to meet specific learning objectives. The innovation stemmed from the application of these core concepts to a patient in the community. Associating a person with a disease or medication was a persuasive and powerful learning experience. These skills, which were the foundation established by the assignments of the Patient Care Project as described in detail in Appendix 1, were then further practiced in future assignments within the curriculum.

Students are required to write patient care plans using the SOAP note format and perform medications history interviews in subsequent therapeutics courses and introductory professional practice experiences. Besides applying classroom skills to a patient in the community, the Patient Care Project also prepared the students for future course work and practice experiences.

The Patient Care Project is not without challenges that must be considered prior to implementation within the curriculum of other doctor of pharmacy programs. To initiate this project, 1 or 2 dedicated courses must focus on the selection of the volunteer patient and the capstone poster presentation. These 2 assignments are key to the success of the entire project and must be emphasized in individual courses. In addition, 1 or 2 dedicated faculty members must be willing to act as the primary resources for students throughout the entire project. These lead faculty members provide support and continuity to both the other faculty members involved and the students. Workload is also a concern for all, but since the bulk of the work associated with the Project was distributed among numerous faculty members, no one was overwhelmed or overburdened. Over time, the level of faculty commitment has been a challenge as well. This challenge can be overcome by the dedication of a core group who mentor faculty members new to the Project. The final challenge involved the individual course assignments, which have changed over time due to alterations in the curriculum and increases in class size. One project, contained in the Principles of Medicinal Chemistry course, was eliminated. Concerns over student performance and possible plagiarism resulted in the changing of another project within the Anatomy and Physiology course. Each project must be carefully chosen to ensure the Patient Care Project's global objectives are met and the integrity of each assignment is maintained. With the work of dedicated faculty members, the challenges described above can be overcome to initiate a successful project.

SUMMARY

The innovative teaching methods described above allowed the faculty members at the University of Cincinnati to achieve the ultimate goal of the Patient Care Project: enhancing the students' perceived understanding of the importance of the pharmaceutical sciences to patient care.

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Appendix 1. Description of Individual Courses and Learning Objectives contained in the Patient Care Project along with Percentage of Academic Credit for Each Specific Assignment (%)

Individual Course Assignments	Individual Assignment Learning Objectives
Longitudinal Patient Care Fall Select a volunteer patient; document disease states and associated medications (7.5%)* Conduct a medication history interview (7.5%)* Complete comprehensive final exam (20%)* Winter Create a patient care plan using the SOAP note format (10%)* Spring Create a written reflective summary of all patient care projects (5%)* Complete a medication summary (5%)* Following Winter: Present a poster that incorporates the knowledge and skills gained from the other projects (40%)*	• Understand pathophysiologic aspects of your patient's condition or disease • Discuss the pharmacodynamics, drug interactions and adverse effects of the assigned drug • Review the physical – chemical properties of the assigned drug • Discuss the use of health care insurance by your patient. • Conduct a patient interview and develop a medication history. • Develop a patient care plan.
Anatomy and Physiology Review the physiological aspects of a disease Perform a critical review of a published journal article on the physiological or pathological aspects of assigned disease state (12%)*	• To gain experience with scientific literature review, evaluation of published scientific information, and preparation of formal written communications. • Value the importance of a strong foundation in anatomy and physiology to the understanding of the principles, effectiveness and toxicities associated with pharmacotherapy
Fundamentals of Pharmacy Practice Final Exam: Create a drug interaction profile on assigned drug using skills developed during course (5%)*	• Identify drug interactions by constructing a drug interaction report and summarizing the information found. • Demonstrate the ability to use a variety of drug information resources to determine the following for the assigned medication/disease state. • Identify the different dosage forms and correct dose • Synthesize patient counseling information. • Summarize information on nutritional supplements that are effective in treating the assigned disease.
Biochemistry Outline the biochemistry for the reactions associated with the disease, the effects on the body and the effects of treatment (4% extra credit)*	• Introduce students to the biochemical bases of disease and drug action. • Improve student's scientific writing ability. • Improve students' scientific research retrieval skills.
Principles of Pharmacology Review the pharmacokinetic properties of the assigned drug focusing on how these properties affect absorption, distribution, metabolism, excretion (ADME) and the dosage form (5%)*	• Improve student's writing skills to summarize specific points from the literature about their drug. • Improve student's ability to research relevant literature about his/her drug. • Foster an understanding of integrating knowledge acquired in different courses.

Communications	
Patient interview focusing on the affects of disease on a patient's life/lifestyle (5%)*	• To help the student develop empathy and skills related to expressing empathy. • Develop interpersonal skills important for healthcare professionals. • Explore patient's health beliefs and feelings about his/her medication use.
Principles of Medicinal Chemistry	
Term paper describing the physical chemical properties of the assigned drug and how they affect ADME. (6%)*	• To help the student connect the physical chemical properties of a drug to the effects of the drug once in the body and the physical chemical properties of a drug to the dosage forms available. • To develop the student's scientific writing skills.
U.S. Health Care System	
Discuss the use of health care insurance for the patient (10%)*	• Given a patient with a specific health insurance profile, classify and describe the patient's health insurance in terms of type of private or public, managed or unmanaged care insurance. • Given a specific patient health care and insurance coverage, describe the advantages and disadvantages of the patient's insurance coverage. • Given a specific patient health care and insurance coverage, determine whether the person's insurance coverage represents a cost efficient use of health resources.

* Percentage denotes the value of this assignment as part of the final course grade

Appendix 2. Grading Standards for Principles of Pharmacology Course

"A" Work

1. Demonstrates ability to critically analyze and resolve problems.
2. Completes assignment within stated time limits.
3. Provides adequate supporting arguments, evidence, examples and details.
4. Demonstrates a thorough understanding of appropriate pharmacokinetic principles.
5. Is able to integrate knowledge from previous and concurrent courses to synthesize answers to questions.
6. Demonstrates learning beyond assigned task.
7. Communicates knowledge and ideas effectively.

"B" Work

Realizes most of 1-7 above, but fails to demonstrate adequate originality, creativity or complete knowledge.

"C" Work

Demonstrates overall competence and meets minimal standards of competence but lacks excellence. May show significant flaws or errors that do not prohibit success but do not demonstrate the highest level of learning.

"F" Work

Fails to demonstrate minimum competence. Does not demonstrate understanding of important principles. May have failed to complete assignment in a timely manner.