

INSTRUCTIONAL DESIGN AND ASSESSMENT

Using Radar Plots for Curricular Mapping to Visualize Assessment in a New Doctor of Pharmacy Program

Matthew R. Dintzner, PhD, Eric C. Nemecek II, PharmD, Kim Tanzer, PharmD, RPh, and Beth Welch, PharmD

Western New England University College of Pharmacy, Springfield, Massachusetts

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Objective. To initiate mapping of the curriculum to the core competencies of our program and to develop a novel and visually accessible method for communicating data to all stakeholders.

Design. An online survey was developed to gauge the extent to which instructors and students perceive that courses within the curriculum and assess students' ability to achieve each of the 10 core competencies. Response data were collected and processed as radar plots in Microsoft Excel.

Assessment. Response rate for faculty members was 100% and 86% for students. Radar plots provided images of the relative extent to which each course surveyed was perceived to contribute to core competencies.

Conclusion. Using radar plots to present perception data is visually descriptive, makes patterns/trends readily apparent, and facilitates the development of an ongoing culture of assessment.

Keywords: assessment, curriculum, mapping

INTRODUCTION

Curricular mapping is the process of making connections between the curriculum and other components of a program, such as its mission and competencies.¹ It is a way of making the curriculum more transparent to stakeholders and may be used to inform the development of a comprehensive assessment plan.² Many innovative approaches to the process of curricular mapping are reported in the literature, including a graphical technique by Plaza and colleagues.³

As a new program, and in anticipation of the Accreditation Council for Pharmacy Education's renewed emphasis on assessment (ACPE 2016 Standards) and in the wake of the launch of the Center for the Advancement of Pharmacy Education (CAPE) 2013 Learning Outcomes,⁴ we recognized an opportunity to identify and incorporate existing best practices of curricular mapping into the development of a comprehensive assessment plan, while putting our own spin on the mapping process.

The doctor of pharmacy (PharmD) program of Western New England University is built on a mission to prepare entry-level practitioners to provide pharmacy care to a diverse population in a variety of settings. The mission is

supported by a set of institutionally defined core competencies that represent the knowledge, attitudes, and abilities graduates are expected to demonstrate upon completing the program. There are 10 core competencies, 5 of which are considered general, and 5 that are considered professional. Each competency is defined by learning outcomes (87 in all; see Appendix 1).⁵ The program is delivered, in part, through the curriculum (Appendix 2), and mapping the curriculum to the competencies through the learning outcomes is a way to assess alignment between the curriculum and the mission (Figure 1).⁶

Assessment and mapping are important components of curricular validation. Arguably, all faculty members are stakeholders regarding content and delivery of a curriculum. However, functionally, not all faculty members are engaged in the idea and process. Radar plots provide clear visual maps of where faculty members' materials lie within the curriculum, which allows for quick gap analyses. Thus, the primary objectives of this project were to initiate the process of mapping the curriculum to the core competencies of our new program and to develop a novel and visually accessible method for communicating the data to stakeholders by using radar plots.⁷

DESIGN

Inspired by the term "mapping," which implies a graphical representation of information using spatial relationships to represent relationships within the data, we developed a visual approach to the curriculum mapping

Corresponding Author: Matthew Dintzner, PhD,
Department of Pharmaceutical & Administrative Sciences,
Western New England University, 1215 Wilbraham Road,
Springfield, MA 01119. Tel: 413-796-2437. Fax: 413-796-
2266. E-mail: matthew.dintzner@wne.edu

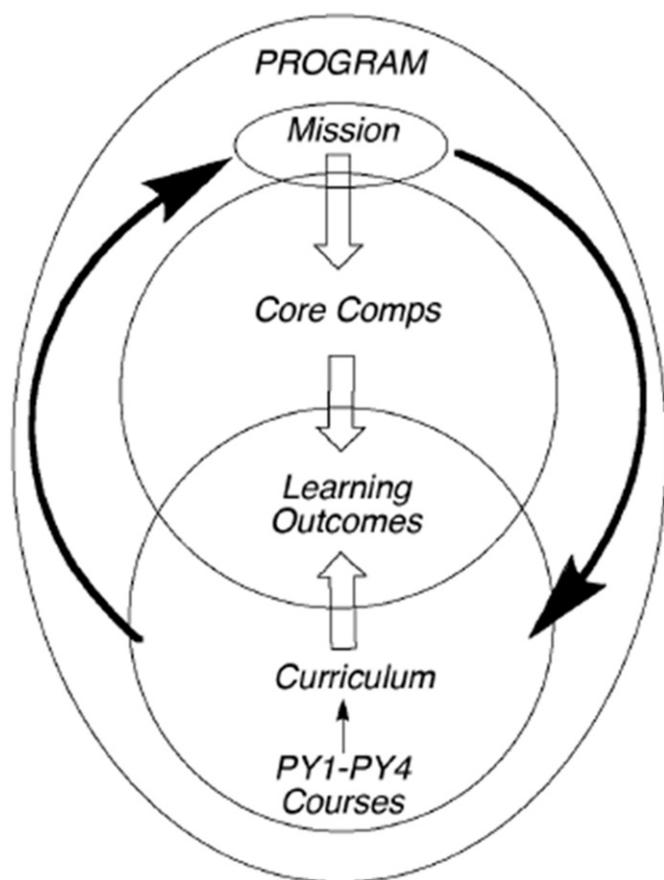


Figure 1. Concept map of program design and alignment between the mission and curriculum.

process through the use of radar plots.⁸ Radar plots are 2-dimensional graphs designed to plot one or more series of values over multiple common quantitative variables by providing an axis for each variable, arranged radially as equiangular spokes around a central point. Radar plots are circular rather than linear, and when the plotted variables are connected with a line, an enclosed shape results, making the data more visually accessible than when displayed in a tabular format. While not appropriate for displaying all types of quantitative data, radar plots are well-suited for efficiently displaying a wide variety of data (and patterns within the data) in a single image.⁹ With regard to curricular mapping, radar plots provide a convenient way to visualize how individual courses contribute to the programmatic “big picture.” For example, consider the radar plots shown in Figure 2 that map 3 hypothetical courses (A, B, and C) to 10 core competencies (I-X). The radial axes correspond to a 4-point Likert scale representing the average level at which the courses are perceived by instructors to assess learning outcomes associated with a given competency as follows: 0=outcome is not assessed; 1=outcome is assessed at an introductory/foundational level as part of a classroom

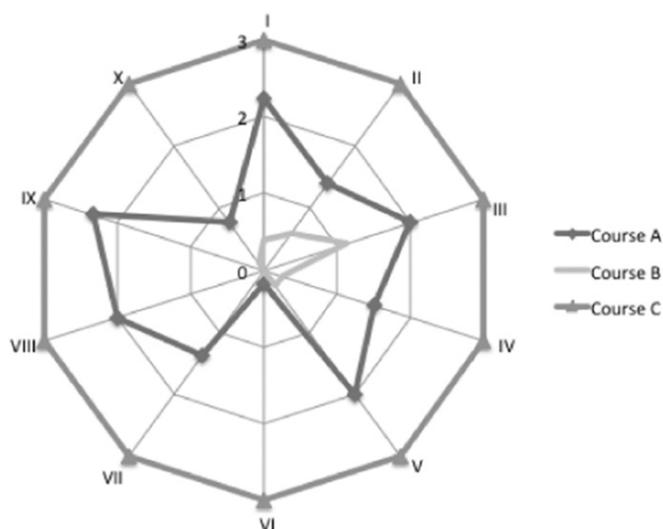


Figure 2. Sample radar plot of hypothetical courses A,B, and C mapped to the 10 Core Competencies.

session, assignment, or examination; 2=outcome is assessed at a higher level as part of a classroom session, assignment, or examination; 3=outcome is assessed in an experiential or simulated setting. The resulting enclosed shapes provide a convenient visual representation of how each course maps to the core competencies. One can see at a glance that course B is perceived to target fewer competencies than course A, and that course C appears to target all 10 competencies to the fullest extent. The same data displayed in a tabular format (Table 1) are not nearly as visually descriptive as the corresponding radar plots. Accordingly, as a way of initiating the curricular mapping process and determining where within the curriculum each of the 10 competencies are thought to be assessed, we surveyed the faculty members.

EVALUATION AND ASSESSMENT

An online survey instrument was developed to gauge instructors’ perceptions of the extent to which all required courses within the curriculum assess the learners’ ability to perform the 87 learning outcomes associated with each of the program’s 10 core competencies.¹⁰ The survey instrument consisted of 87 learning outcome statements and a 4-point Likert scale indicating the extent to which each

Table 1. Mapping Data for Three Hypothetical Courses

Course	Core Competency									
	I	II	III	IV	V	VI	VII	VIII	IX	X
A	2.2	1.4	2.0	1.5	2.0	0.2	1.4	2.0	2.3	0.8
B	0.4	0.6	1.1	0.3	0.3	0	0	0	0	0.1
C	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0

outcome was thought to be assessed in a given course. The 4-point Likert scale was developed simply to help us get a “lay of the land” at this phase of our assessment plan.

The survey was administered electronically to instructors of record for all required courses in the curriculum through SurveyMonkey (SurveyMonkey, Palo Alto, CA), and it had a 100% response rate (48 surveys administered with 48 responses). Response data were exported to Microsoft Excel, where they were condensed by averaging the results for the learning outcomes associated with each of the 10 competencies. The calculated average scores for each competency then were used to generate radar plots in Microsoft Excel for each course similar to those shown in Figure 3.

The resulting plots were analyzed qualitatively to identify trends, gaps, and overlaps. We administered a similar survey to a sample of learners to ascertain alignment between instructors’ and students’ perceptions. Volunteers were solicited from the classes of 2016 and 2017. The first 10 respondents from each cohort were sent a link to the survey for 3 different courses and given one week to complete it. The data were worked up and analyzed as described above. We chose to survey only a sample of students for a few selected courses simply to gauge alignment. Administering an 87-question survey to all students for all courses would have been not only prohibitively demanding, but also beyond the scope of this project. This work received exempt status from the Western New England University Institutional Review Board.

DISCUSSION

While it is not the objective of this article to present a rigorous analysis of our curriculum, as perception data alone are not sufficient to directly assess achievement of competencies, what follows is a brief discussion of some of the trends that we were able to spot with our radar plots.

Sample radar plots are shown in Figure 3 for 2 representative courses based on instructors’ perceptions of the learning outcomes assessed in those courses. Different courses target different core competencies and, therefore,

generate their own shapes on the radar plot. For example, Introduction to Pharmacy is perceived to most significantly assess the core competency Active Citizenship and Leadership, while Principles of Medicinal Chemistry targets core competencies Thinking and Learning and Knowledge Base.

We observed that similar courses, such as those in the physical sciences, target similar competencies and generate similar-looking shapes on the radar plot (Figure 4). The maps in Figure 5 show that core competencies Thinking and Learning and Knowledge Base are perceived to be emphasized in these courses and that the course Genetics and Genomics also is perceived to target the core competencies Social and Cultural Awareness, Ethical and Legal Judgment, and Communication, as might be expected.

In addition to mapping individual courses to all of the core competencies, we mapped all courses or groups of courses to a single competency. For example, in order to determine which courses within the curriculum are thought to emphasize Thinking and Learning, a radar plot such as the one shown in Figure 5 was generated. In this single image, we could pinpoint which courses were perceived to contribute most significantly to this competency.

Radar plots also are useful for assessing progression from year to year or for sequences of courses meant to build on one another, as we observed for first-year and second-year professional development courses. For these courses, 2 instructors completed the survey instrument separately, with results suggesting a perceived natural progression toward the same set of core competencies (I-V, Figure 6). Moreover, when a course series (eg, course 1 and subsequent course 2) is analyzed, an instructor can visualize the extent to which the continuation enhances learning outcomes in the second offering.

Although we were primarily interested in instructors’ perceptions at this stage of our assessment project, we also surveyed a sample of learners. For most courses for which the students completed the survey, including Practice Management I (Figure 7), we observed reasonably good

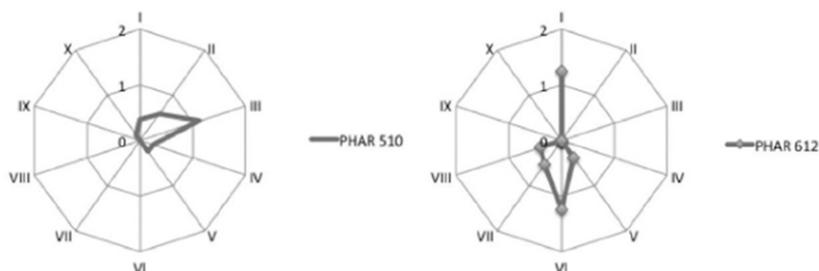


Figure 3. Radar plots of two representative courses (PHAR 510 and 612) mapped to the 10 Core Competencies.

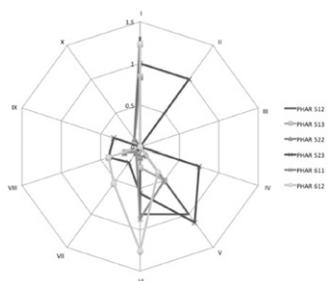


Figure 4. Radar plots of physical science courses mapped to the 10 Core Competencies.

alignment (defined as gross visual overlap in the radar plot) between instructor and student perceptions with regard to which core competencies were assessed. Generally, students perceived they were being assessed at a higher level relative to instructors' perceptions (Figure 7). The observed gap between the perception of learners and that of instructors was significant ($p < 0.05$), which we reasoned was likely because of the learners' limited perspective of the big picture.¹¹ However, the visual cue of overlap is the key message when analyzing the radar plot.

Ultimately, this mapping process provided indirect evidence that all 87 learning outcomes were assessed in at least one course or practice experience within the curriculum. No gaps were detected, and no 2 courses were identically mapped to the learning outcomes and core competencies (ie, no unnecessary duplication was observed). Thus, the first 3 years of the curriculum (mainly didactic courses) provide learners with opportunities to establish a solid foundation in the core competencies, while the fourth-year curriculum (mainly experiential) is perceived to assess the learners at a higher level, especially for core competencies Patient-Centered Pharmaceutical Care,

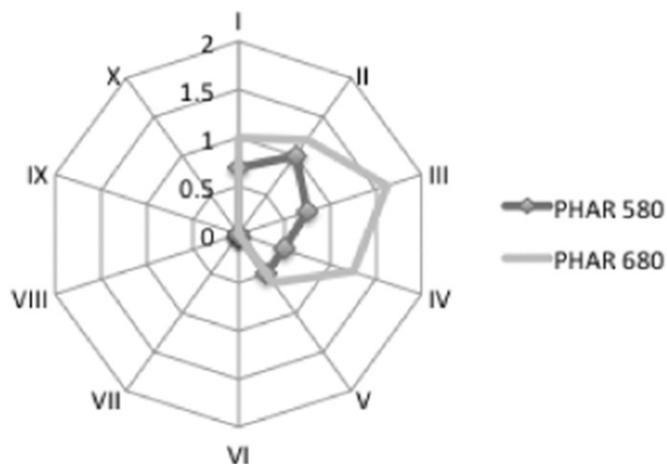


Figure 6. Radar plot showing perceived progression in sequenced courses.

Populations-Based Pharmaceutical Care, Systems Management, and Public Health and Wellness, which more heavily involve the psychomotor domain of learning ("doing"). We will use this knowledge to guide the next phase of our assessment plan: direct assessment of student learning. For this, we also intend to use radar plots to assess alignment between what we perceive the students are learning and what they are actually learning.

CONCLUSION

Using radar plots to present perception data is visually descriptive and shows patterns/trends that may facilitate the development of an ongoing culture of assessment. As a result of using radar plots, we have a sense of where and to what extent the core competencies are being assessed within the curriculum.

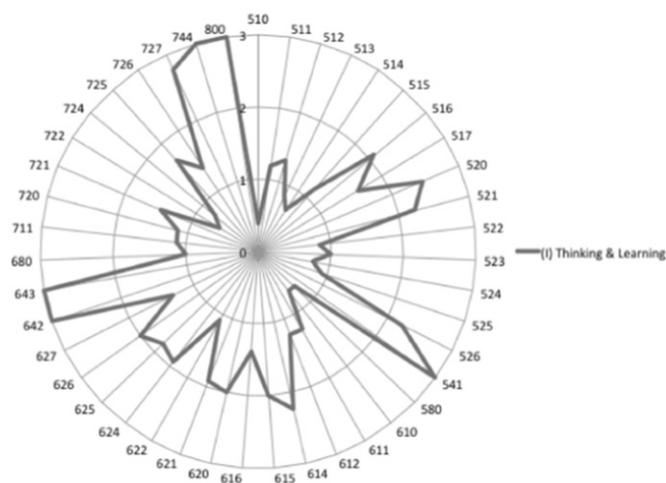


Figure 5. Radar plot of Core Competency I (Thinking and Learning) mapped to all courses (shown as course numbers around the perimeter of the plot).

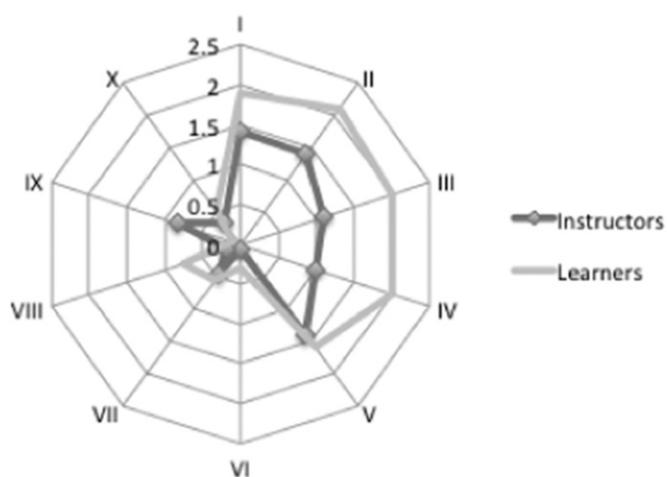


Figure 7. Radar plot showing alignment of learner and instructor perception for the course Practice Management I.

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Appendix 1. Core Comps and Learning Outcomes

Competency	Learning Outcome ⁵
(I) Thinking and Learning (general)	The competent graduate is able to:
	1 Identify and analyze the important factors associated with a given a problem
	2 Gather relevant situational information associated with a given problem
	3 Effectively interpret information relative to a given problem
	4 Establish relevant criteria and standards for acceptable solutions to a given problem
	5 Construct well-reasoned, fact-supported solutions to a given problem
	6 Integrate scientific, social, cultural, legal, economic, and ethical factors in making decisions and solving problems
	7 Articulate a system for evaluating the results of decisions made and revise as necessary
	8 Interpret assessment feedback to identify own areas of strengths, and areas needing refinement/remediation
	9 Demonstrate effective self-assessment and self-improvement in areas of knowledge, skills, habits and attitudes
	10 Demonstrate a commitment to lifelong learning by assuming responsibility for his/her own learning, including assessment of learning needs, development of personal learning plans, self-assessment of knowledge level, skills, attitudes, and values, and achievement of desired competencies and outcomes
	11 Evaluate medical and scientific literature
	12 Assess information needs of patients and health providers
(II) Social and Cultural Awareness (general)	13 Apply knowledge of study design and literature analysis/retrieval to provide accurate, evidence-based drug information
	14 Demonstrate an awareness of health care and professional issues within appropriate frameworks (historical, cultural, social, economic, political, and/or philosophical)
	15 Identify key issues facing the contemporary world and the environmental, political, social, cultural factors, people, and institutions that shape them
	16 Demonstrate an ability to compare and contrast essential cultural and social similarities and differences between his/her own and other cultures
	17 Develop and apply a personal value system and approach to social and cultural engagement
	18 Demonstrate sensitivity and tolerance within a culturally diverse society

(Continued)

Appendix 1. (Continued)

Competency	Learning Outcome ⁵	
(III) Active Citizenship and Leadership (general)	19 Demonstrate an appreciation of the obligation to participate in efforts to help individuals	
	20 Demonstrate an appreciation of the obligation to participate in efforts to improve society	
	21 Demonstrate an appreciation of the obligation to participate in efforts to improve the health care system	
	22 Demonstrate a knowledge of different leadership styles and adopt an appropriate style for a given situation	
	23 Demonstrate an appreciation of the obligation to participate in efforts to help advance the pharmacy profession	
	24 Demonstrate an ability to function as a leader at an appropriate level	
	25 Articulate and demonstrate the role of an enlightened citizen	
	26 Demonstrate leadership abilities in community activities that involve health and human service initiatives focused on individuals or groups	
	(IV) Ethical and Legal Judgment (general)	27 Make rational, ethical decisions regarding complex personal, societal, and professional situations within a context of personal and professional values
		28 Make decisions and actions based on integrity, responsibility, compassion, empathy, and respect
29 Demonstrate ethical and professional behavior in all practice activities		
30 Comply with all federal, state, and local laws related to pharmacy practice		
(V) Communication (general)	31 Communicate clearly, accurately, and persuasively with various audiences using a variety of methods and media	
	32 Function effectively in interactions with individuals	
	33 Function effectively in group situations	
	34 Function effectively within professional organizations and systems	
	35 Search the medical and scientific literature using current technology	
	36 Effectively counsel patients regarding their drug therapy	
	37 Demonstrate the ability to write professional reports or manuscripts	
	38 Effectively use computers	
(VI) Knowledge Base (professional)	39 Demonstrate a thorough knowledge base in structure, function, biosynthesis, and catabolism of biomolecules	
	40 Demonstrate a thorough knowledge base in the utilization of immunology and/or molecular biology in the production and use of pharmaceuticals	
	41 Demonstrate a thorough knowledge base in physiochemical properties of pharmaceutical dosage forms	
	42 Demonstrate a thorough knowledge base in compounding techniques	
	43 Demonstrate a thorough knowledge base in commercial production of pharmaceutical dosage forms	
	44 Demonstrate a thorough knowledge base in time course of drug absorption, distribution, metabolism, and excretion, and the factors that influence these processes	
	45 Demonstrate a thorough knowledge base in pathophysiology of diseases at the molecular, cellular, and organ level	
	46 Demonstrate knowledge of and accept responsibility for the knowledge of commonly used medications, formulations, and drug products	
	47 Demonstrate a thorough knowledge base in the structure-activity relationships of drugs	
	48 Demonstrate a thorough knowledge base in the mechanisms of actions of drugs	
	49 Demonstrate a thorough knowledge base in bio-transformations of drugs	
	50 Demonstrate a thorough knowledge base in the pharmacologic effects of drugs	
	51 Demonstrate a thorough knowledge base in the adverse effects and contraindications of drugs	
	52 Demonstrate a thorough knowledge base in the toxicological effects of other chemicals	
	53 Demonstrate a thorough knowledge base in the proper use of drugs in patients of all ages including those with multiple diseases, complex drug regimens, and physiologic alterations	
	54 Demonstrate knowledge of a wide array of private and public health insurance options to assist patients and caregivers to obtain their medications and related para-pharmaceuticals in an affordable manner that meets their health care needs	

(Continued)

Appendix 1. (Continued)

Competency	Learning Outcome ⁵	
(VII) Patient-Centered Pharmaceutical Care (professional)	55 Provide patient-centered care in collaboration with interprofessional health care providers, as well as the patient and their caregivers in order to produce optimal medication therapy outcomes	
	56 Provide pharmacy care based on sound therapeutic principles and evidence-based data	
	57 Design, implement, monitor, evaluate, and adjust pharmaceutical care plans that are patient-specific and evidence-based	
	58 Communicate and collaborate with prescribers, patients, care givers, and other involved health care providers to engender a team approach to patient care	
	59 Retrieve, analyze, and interpret the professional, lay, and scientific literature to provide drug information to patients, their families, and other involved health care providers	
	60 Carry out duties in accordance with legal, ethical, social, economic, and professional guidelines	
	61 Maintain professional competence by identifying and analyzing emerging issues, products, and services that may impact patient-specific therapeutic outcomes	
	62 Demonstrate a commitment to and a valuing of patient safety by assuring accurate preparation, labeling, dispensing, and distribution of prescriptions and medication orders	
	63 Collect, record, and assess subjective and objective patient data to define health and medication-related problems	
	64 Correlate drug related variables and patient related variables to identify and assess drug related problems	
	65 Evaluate how the unique characteristics of patients impact on manifestations of drug-related problems	
	66 Utilize pharmaceutical and pharmacokinetics mathematics to perform accurate medication calculations	
	67 Value the importance of total accuracy in performing and applying medication calculations	
	(VIII) Population Based Pharmaceutical Care (professional)	68 Provide therapeutic guidance in the provision of population-based care as part of an interprofessional collaboration
		69 Develop and implement population-specific programs and protocols based on sound therapeutic principles and evidence-based data
70 Retrieve, analyze, and interpret the professional, lay, and scientific literature to provide drug information to other health care providers and to the public		
71 Maintain professional competence by identifying and analyzing emerging issues, products, and services that may impact population-based, therapeutic outcomes		
72 Evaluate how the unique characteristics of patient populations impact on manifestations of drug-related problems		
(IX) Systems Management (professional)	73 Apply relevant legal, ethical, social, economic, and professional principles/issues to assure efficient, cost-effective utilization of human, physical, medical, informational, and technological resources in the provision of patient care	
	74 Communicate and collaborate with patients, prescribers, other health care providers, and administrative and supportive personnel to engender a team approach to assure efficient, cost-effective utilization of human, physical, medical, informational, and technological resources in the provision of patient care	
	75 Maintain professional competence by identifying and analyzing emerging issues, products, and services that may impact management of human, physical, medical, informational, and technological resources in the provision of patient care	
	76 Apply patient- and population-specific data, quality assurance strategies, and research processes to assure that medication use systems minimize drug misadventuring and optimize patient outcomes	
	77 Apply patient- and population-specific data, quality assurance strategies, and research processes to develop drug use and health policy, and to design pharmacy benefits	
	78 Communicate and collaborate with prescribers, patients, caregivers, other involved health care providers and administrative and supportive personnel to identify and resolve medication use problems	

(Continued)

Appendix 1. (Continued)

Competency	Learning Outcome ⁵	
(X) Public Health and Wellness (professional)	79	Proactively promote the importance of good health and disease prevention in cooperation with patients, communities, at-risk populations, and other health care professionals for the public welfare
	80	Assure the availability of effective, quality health and disease prevention services and participate in activities that promote health and wellness and the use of preventive care measures
	81	Apply population-specific data, quality assurance strategies, and research processes to develop, identify, and resolve public health problems
	82	Promote the importance of management of disease states and medication therapies to optimize outcomes
	83	Communicate and collaborate with prescribers, policy makers, members of the community, and other involved health care providers and administrative and supportive personnel to identify and resolve public health problems
	84	Maintain professional competence by identifying and analyzing emerging issues, products, and services that may affect the efficacy or quality of disease prevention services to amend existing or develop additional services
	85	Apply population-specific data, quality assurance strategies, and research processes to develop public health policy
	86	Communicate and collaborate with prescribers, policy makers, members of the community, and other involved health care providers and administrative and supportive personnel to develop public policy
	87	Maintain professional competence by identifying and analyzing emerging issues, products, and services that may affect public health policy, to amend existing or develop additional policies

Appendix 2. Western New England University College of Pharmacy Curriculum

Fall Semester		Spring Semester	
Course #	Title	Course #	Title
PY-1			
510	Introduction to Pharmacy	520	Health Care Communications
511	Informatics I	521	Informatics II
512	Immunology	522	Pathophysiology
513	Biochemistry	523	Genetics and Genomics
514	Pharmaceutics I	524	Pharmaceutics II
515	Pharmaceutics I Lab	525	Pharmaceutics II Lab
516	Pharmacy Ethics	526	Pharmacy Outcomes
517	Health Care Policy & Delivery	540/541	IPPE
580	Professional Development I	580	Professional Development I
PY-2			
610	Pharmokinetics	620	Self Care Therapeutics
611	Pharmacology	621	IPC & PM ^a Renal
612	Medicinal Chemistry	622	IPC & PM Respiratory
614	Patient Assessment Skills Lab	623	IPC & PM CVS 1
615	Professional Pharm Practice Lab	624	IPC & PM CVS 2
616	Practice Management I	625	Applied Pharmacy Care I
642/643	IPPE	626	Practice Management II
65#	Elective	627	Sterile Products Lab
680	Professional Development II	65#	Elective
		680	Professional Development II

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Appendix 2. (Continued)

Fall Semester			Spring Semester		
Course #	Title		Course #	Title	
PY-3					
710	IPC & PM GI		720	IPC & PM Derm	
711	IPC & PM Endocrine		721	IPC & PM Neuro	
712	IPC & PM Infectious Disease 1		722	IPC & PM Psych	
713	IPC & PM Infectious Disease 2		723	IPC & PM Heme/Onc	
715	Applied Pharmacy Care II		724	IPC & PM Spec Pops	
744/745	IPPE		725	Applied Pharmacy Care III	
75#	Elective		726	Pharmacy Law	
780	Professional Development III		727	Patient Care Management (Capstone)	
			780	Professional Development III	
PY-4					
Summer		Fall		Spring	
800	APPE	802	APPE	804/805	APPE
801	APPE	803	APPE	807	APPE
880	Prof. Dev. IV	880	Prof. Dev. IV	880	Prof. Dev. IV

^aIPC & PM=Integrated Pharmacy Care and Practice Management