

Integrating Medicinal Chemistry and Pharmacology into a New Course Sequence in the PharmD Curriculum

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Introduction

The importance of biomedical and pharmaceutical sciences in pharmacy education is highlighted in Accreditation Council for Pharmacy Education (ACPE) Standards, where Guideline 13 requires schools of pharmacy to establish a curriculum that provides students with the scientific knowledge that would assist them in achieving competencies in the different disciplines of pharmacy, which include the biomedical and pharmaceutical sciences and in the CAPE Educational Outcome that includes developing, integrating, and applying knowledge from the foundational sciences.

An interest in integrating curricular topics is growing in higher education generally, and particularly in the biomedical field. Many factors which likely contribute to this increased interest in integration include:

- Continued growth of knowledge
- A need for relevance in the curriculum
- Improved retention
- Increased student-faculty interactions

Advantages of integrated, interdisciplinary coursework include:

- Increased application skills among students
- Better faculty understanding of what is taught across the curriculum

However, a number of potential challenges are inherent in this integration:

- Possible overlap of material/content
- Faculty disagreement over content
- Poor coordination on examinations
- Ineffective integration of material
- Intensive faculty effort required

As part of the curricular revision initiated in Fall 2010 at the University of Michigan College of Pharmacy, pharmacology and medicinal chemistry, were combined into one course sequence called Principles of Drug Action. This integration, coupled with a higher commitment to active learning and alignment with clinical coursework, attempted to address numerous redundancies, the occasional disconnect between the two courses, and a perception by students of a lack of relevance of these disciplines to pharmacy and pharmaceutical care.

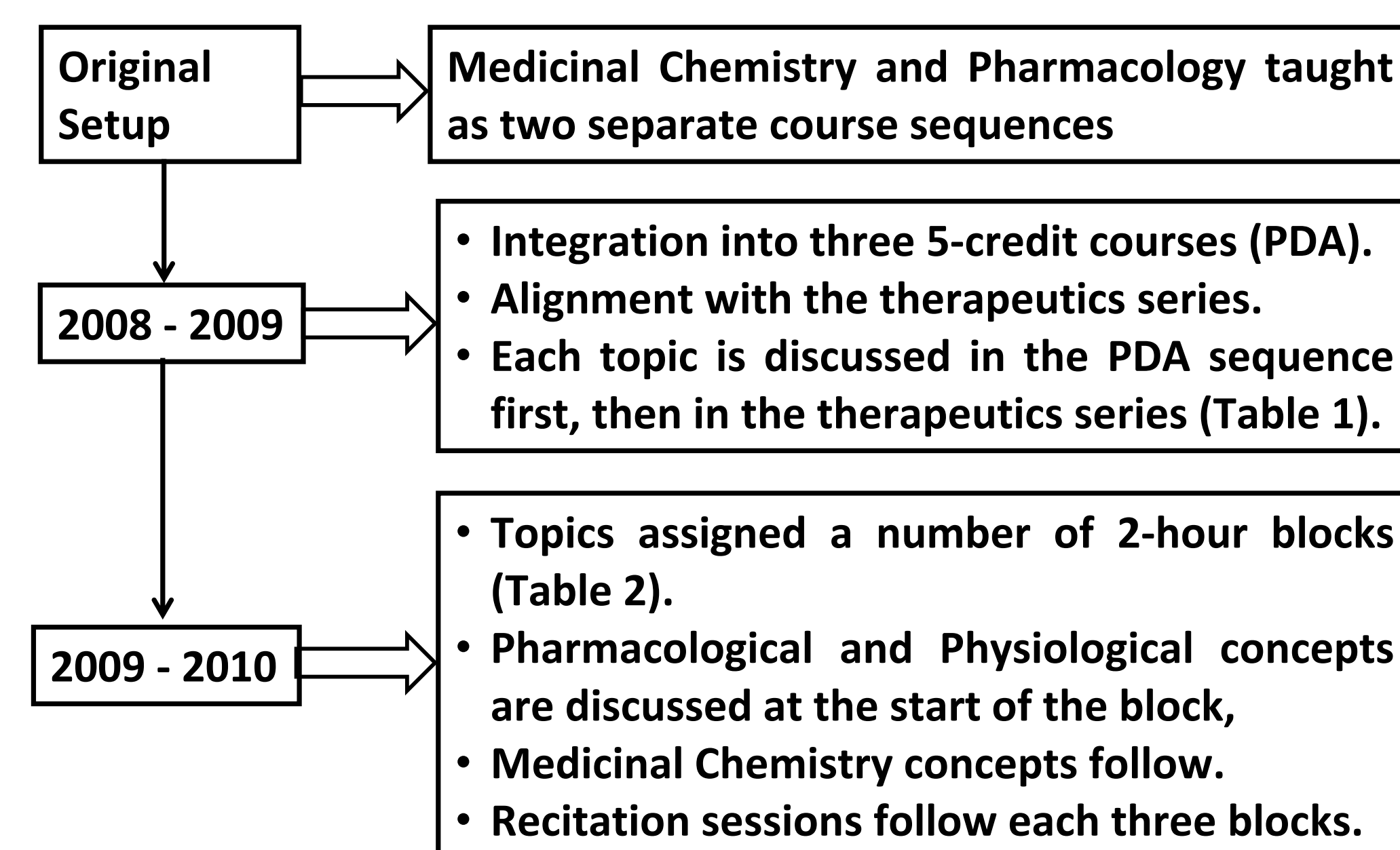
Objectives

To assess the implementation of integrated medicinal chemistry and pharmacology courses named Principles of Drug Action (PDA).

- This model integrates medicinal chemistry and pharmacology, while aligning the presentation of topics with the clinical sciences courses, without a formal integration of all three disciplines.
- The model retains basic science concepts in the curriculum with the delivery of the designated content by experts from each discipline.
- The model also allows for discussion of each topic at more than one point in the curriculum, rather than covering each topic singularly in one course.

The study examines innovative components of the course sequence such as an in-class remediation, recitation sessions that aim to bring a clinical flavor to the basic science courses, and inclusion of the Top 200 Drugs modules, which were aligned with the drug groups discussed in the course sequence to provide students with the science background to help learn these modules.

The Integration Process



Topic	Centrally-acting Agents	Cardiovascular Agents	Diabetes
Prior to Integration			
Medicinal Chemistry	Winter (S) – P1 year	Fall (S) – P2 year	Fall (F) – P2 year
Pharmacology	Fall (S) – P2 year	Winter (F) – P2 year	Winter (S) – P2 year
Therapeutics	Fall (S) – P3 year	Winter (F) – P3 year	Winter (S) – P2 year
Integrated course			
PDA	Fall (S) – P2 year	Winter (S) – P1 year	Fall (F) – P2 year
Therapeutics	Winter (F) – P2 year	Fall (F) – P2 year	Fall (S) – P2 year

F = first half of the semester; S = second half of the semester; PDA = Principles of Drug Action

Number of 2-hour blocks	Three plus recitation session
Block 1 – first hour	Pharmacology of sympathetic nervous system Different adrenergic receptors including signal transduction Adrenergic neurons including biosynthesis, storage, and metabolism of neurotransmitters
Block 1 – second hour	Physiological effects of stimulating adrenergic receptors Chemistry of norepinephrine and epinephrine biosynthesis and metabolism Receptor binding of norepinephrine, epinephrine and related agents Agents that act at adrenergic neurons and their SAR
Block 2 – first hour	Pharmacology of adrenergic agonists and their clinical application
Block 2 – second hour	Chemistry of adrenergic agonists including their SAR, receptor binding and metabolism
Block 3 – first hour	Pharmacology of adrenergic antagonists and their clinical application
Block 3 – second hour	Chemistry of adrenergic antagonists including their SAR, receptor binding and metabolism

Recitation Sessions

Two-hour recitation sessions are run by three Graduate Student Instructors, following each set of three 2-hour lecture blocks.

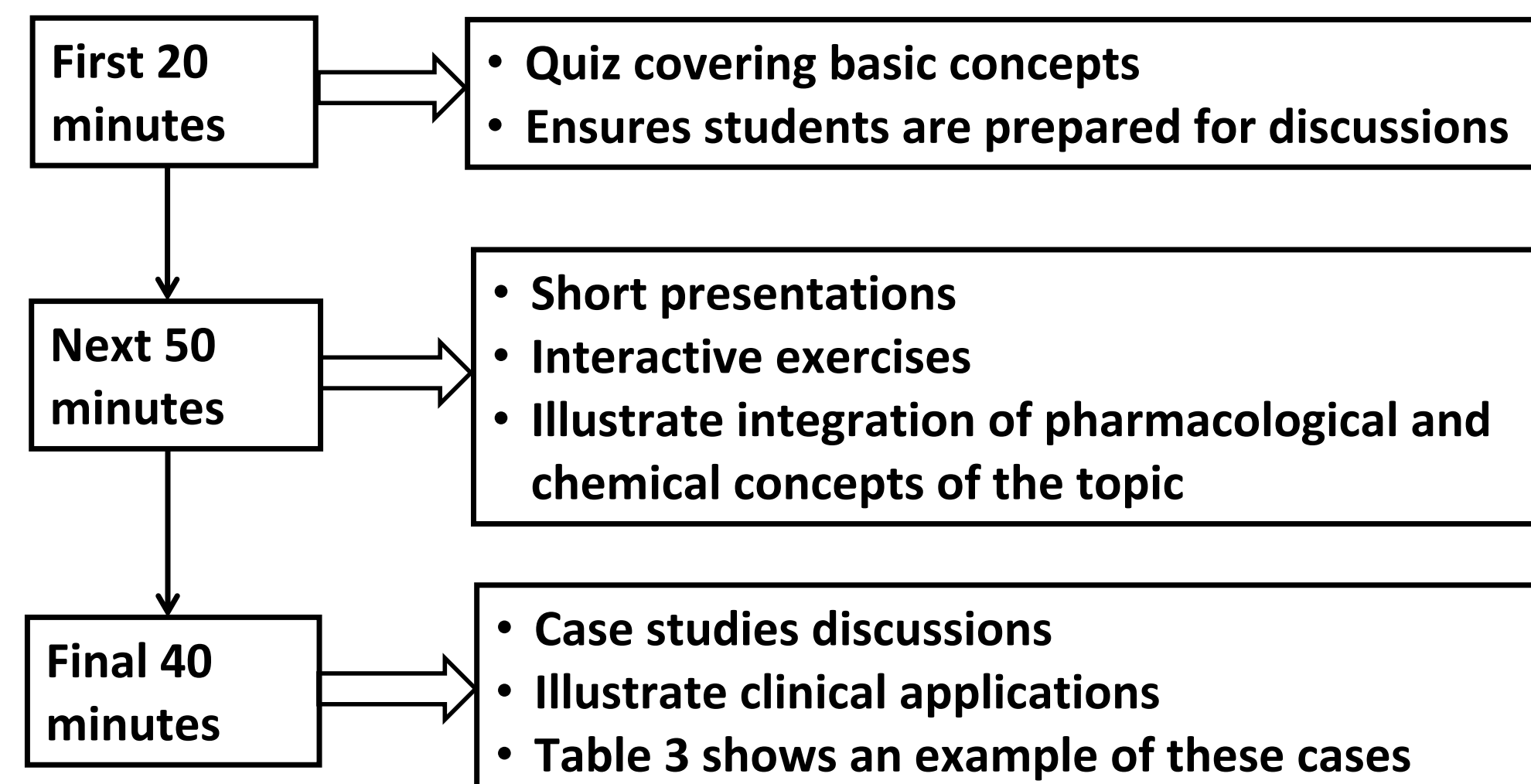


Table 3: Example of Cases Studies Used in Recitation Sessions

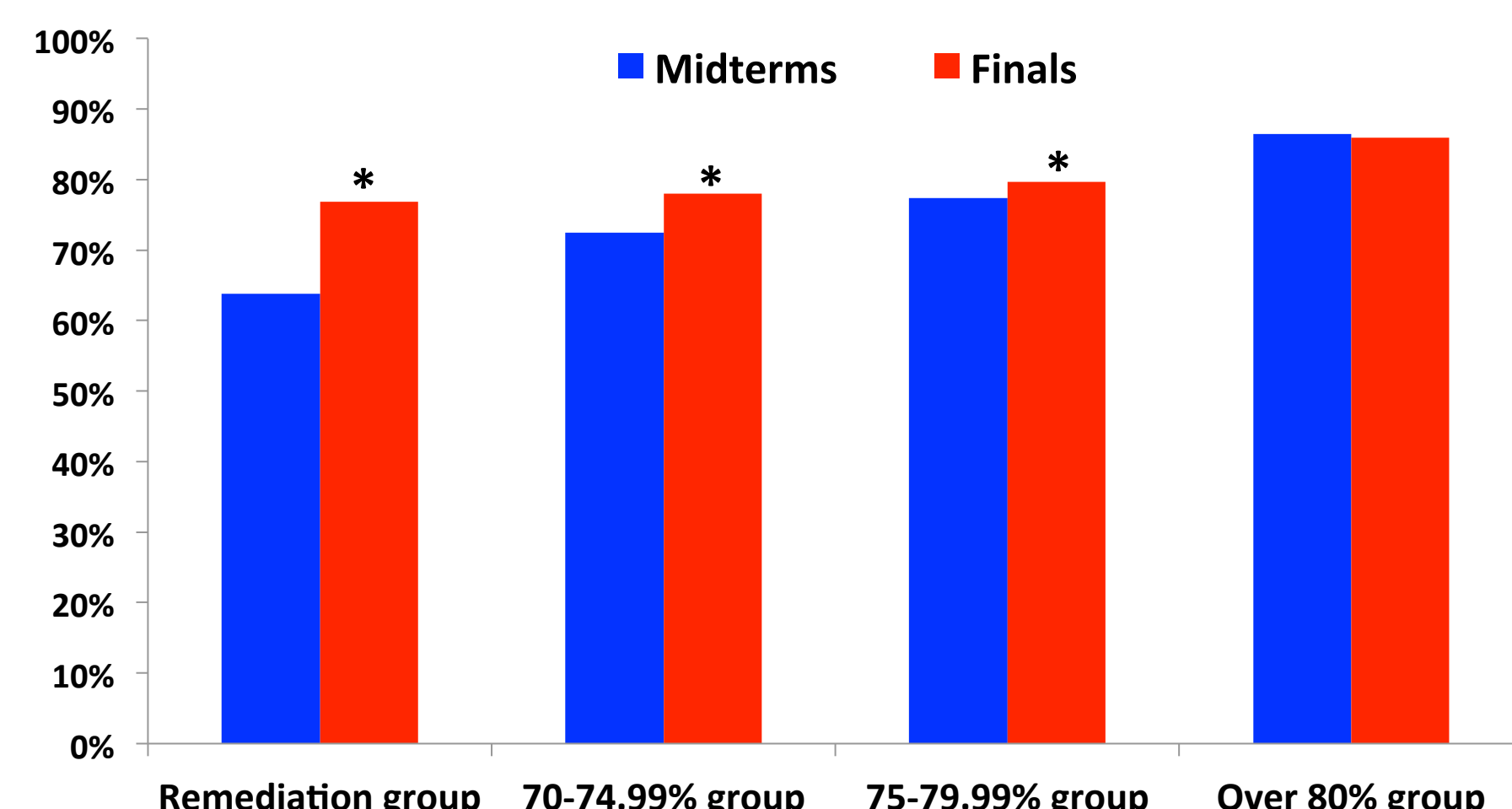
A 68 year old female presents with “a swollen left calf” that has been red and tender for 2 days. An ultrasound shows a deep vein thrombosis in the left leg only. She is 5’4” tall and weighs 50 kg. Her BUN/Cr is 15/2.5. The physician wants to use Enoxaparin and ask you to dose it.
A. What dose do you use, what factors do you take into consideration?
B. How will you monitor her?
C. Seven days after starting the Enoxaparin the patient’s platelets drop from 280,000 to 40,000. She complains that her right calf is now hurting, it is also now red and tender and an ultrasound shows a new DVT in her right leg as well as some progression in her original clot in her left. What could be happening here and what do you do?

Remediation Plan

An in-class remediation process was included as part of the courses, with the primary purpose to ensure that students become competent in each unit, since it is conceivable that a student fails one or more unit exams, but still passes a given course.

Students failing any of the unit exams are given a list of competencies they need to achieve in that section of the course. Students are given two weeks to review the section, provided with some learning-aid tools and are then asked to take a minimal competency assessment. Students passing the remedial exam receive up to 10% of the total midterm exam grade, but not to exceed 70% on that failed midterm.

Results: Students participating in the remediation process out-paced their peers in term of score improvement on the final cumulative exam (Figure 1).



* Indicates significant difference (p < 0.05) using paired t-test

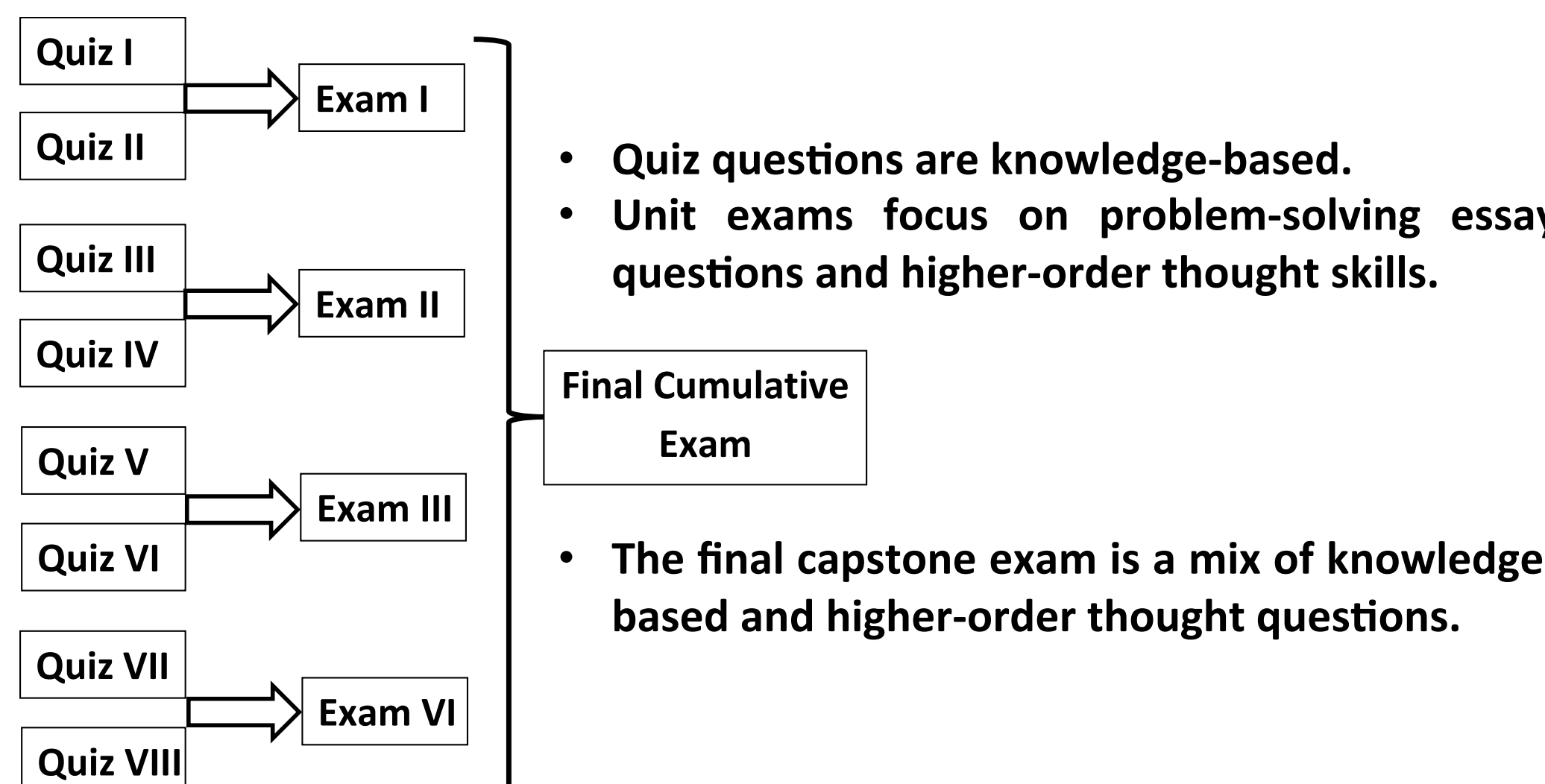
Figure 1: Comparison between Midterm Exams’ Scores and Corresponding Units on the Final Cumulative Exam for Four Courses in the Sequence

Top 200 Modules

A requirement to successfully complete the PharmD curriculum at the college is to pass a high-stakes examination covering the Top 200 Drugs, based on sales in the United States.

- Students are required to complete self-learning modules and quizzes throughout each of their first four semesters.
- The Top 200 drugs modules were integrated into the Principles of Drug Action sequence and were aligned with the topics discussed in class.

Course Assessments



- Quiz questions are knowledge-based.
- Unit exams focus on problem-solving essay questions and higher-order thought skills.

- The final capstone exam is a mix of knowledge-based and higher-order thought questions.

In-Course Evaluation

- During the first installment of the course sequence, student input was sought via a course Facebook group run by the student researcher, which focused on weekly discussions about one or two issues.
- At the end of each week, the student researcher prepared an anonymous summary of the topics discussed for the course director.
- Based on this feedback, changes to the course in areas such as the recitation sessions, teaching approach, and the integration process were implemented.

Post-Course Evaluation

A survey was administered at the end of the semester to students enrolled in the first year and was the basis for changes in subsequent years.

- The survey was composed of 11 questions using a 5-point Likert scale and 1 free-text comment. The results from the survey are shown in Table 4.
- Two groups of six student volunteers each met with a student researcher, once mid-semester and once at the end of the semester.
- The student researcher conducted one-on-one interviews with two key faculty members and the three graduate student instructors involved in the course during the summer of 2011.

Question	Strongly agree/agree	Strongly disagree/disagree	Mean (SD)
I believe that the integration of medicinal chemistry and pharmacology into one course was a beneficial change in the pharmacy curriculum.	78%	3%	4.0 (0.098)
As the semester progressed, the instruction and structure of the course improved.	92%	0%	4.51 (0.075)
The course would have been more efficient with fewer professors.	81%	11%	4.08 (0.11)
The recitation sessions were effective and beneficial to my learning.	58%	25%	3.53 (0.127)
I agree that this course should offer a remediation plan to students who fail examinations.	94%	3%	4.53 (0.095)

- To investigate the effect of integration of the two course sequence on student learning, the study looked at final letter grades from one course from each discipline in the two years prior to integration (2009 and 2010) and compared them to letter grades in the equivalent course in the new sequence in the most recent two years after integration (2013 and 2014).
- The study looked at the letter grade range (A-D) and converted each letter grade to the point average as defined by the University of Michigan). For the two courses prior to integration, the average grade point average from the two courses for each student was calculated. Results are shown in Figure 2.

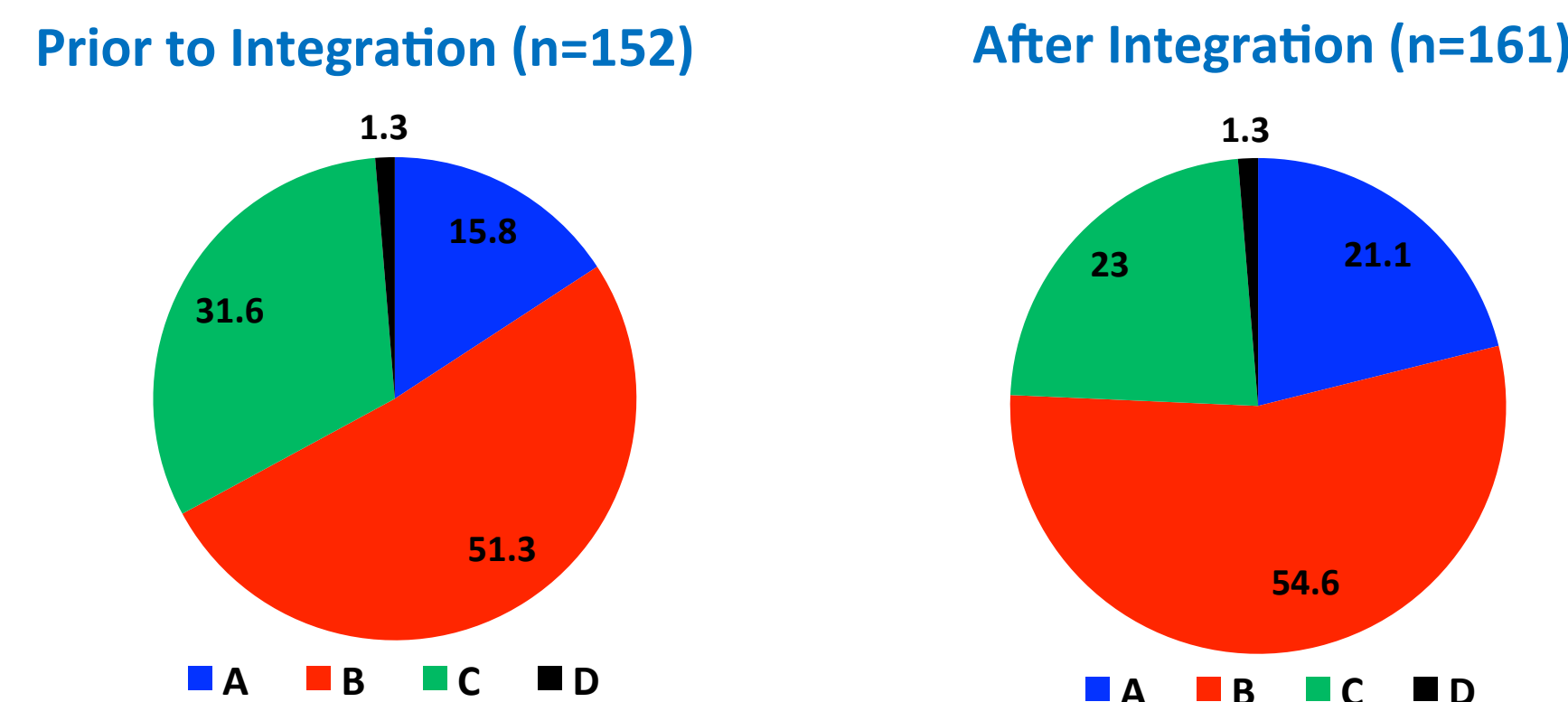


Figure 2. Comparison of Letter Grades Prior and After the Integration Process

Table 5 compares the mean scores on three common questions used at the University of Michigan as part of the student rating of the courses for the integrated course (2010-2013) versus those prior to integration (2008-2010).

Question	Prior to Integration, mean (SD); n = 322	Post Integration, mean (SD); n = 193	p-Value
Overall, this was an excellent course	3.25 (0.066)	3.80* (0.061)	<0.0001
I learned a great deal from this course	3.67 (0.056)	4.38* (0.05)	<0.0001
I had a strong desire to take this course	3.60 (0.063)	3.87* (0.067)	<0.0001

* Indicates significant difference (p < 0.05) using unpaired t-test

Conclusions

- Implementation of the new integrated medicinal chemistry/pharmacology course sequence resulted in a successful transition from the independent courses model to an integrated course sequence that addressed shortcomings of the old model, provided opportunity for active learning and applications to the clinical setting, and highlighted the relevance of these basic science disciplines to pharmaceutical care.
- The majority of survey participants, focus groups, and Facebook discussion groups agreed that integration of the two courses was a beneficial change to the curriculum and supported the elements of the new course sequence.
- Course evaluations showed that students were more satisfied and felt they learned better in the integrated course than in the previous individual courses.
- The remediation process ensured that all students completing the course achieved an acceptable level of mastery in all individual sections of the course and appear to have a positive outcome on student learning.
- The effect of integration on student learning showed promising but limited improvement.
- Faculty buy-in and involvement is critical to a successful integration.
- Other key factors that seemed to help make this transition successful include fostering student engagement, seeking their immediate feedback and implementing suggestions when possible.
- This model could be utilized in professional health sciences programs considering integration of basic science courses without going to a fully integrated model of teaching.

Future Directions

- To address concerns about workload raised by students and faculty, the series has moved to a five-course sequence (3 and 4 credit courses) in place of the three-course sequence (5 credits each) starting in Fall 2015.
- Changes to the recitation sessions to enable a more interactive environment will commence in the Fall 2015, as around one quarter of the students did not feel that the sessions benefited their learning.
- Better integration of the material will be a major focus in the new sequence.