

Evaluating Pharmacy Students' Practice Readiness: Insights from Academic and Experiential Performance at University of Waterloo

by

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Author's Declaration

The thesis consists of material all of which I authored or co-authored: see Statement of Contributions included in the thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

I understand that my thesis may be made electronically available to the public.

Statement of Contributions

Ali Syed was the sole author for Chapters 1, 2, 3, and 7, which were written under the supervision of Dr. Nancy Waite and Dr. Sherilyn Houle and were not written for publication.

This thesis consists in part of three manuscripts written for publication. Exceptions to sole authorship of material are as follows:

Research Presented in Chapter 4:

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This research was conducted at the University of Waterloo by Ali Syed under the supervision of Dr. Nancy Waite and Dr. Sherilyn Houle. Ali Syed conceived the research question and objectives with assistance from Dr. Waite and Dr. Houle. Ali Syed devised the research outline and requested and obtained data from the University of Waterloo School of Pharmacy and the Office of the Registrar. Ali Syed created the research ethics application for the University of Waterloo Research Ethics Board. Dr. Sarah Moroz assisted with data extraction, de-identification and cleaning. Yuying Huang, Joslin Goh, and Ali Syed conducted the data analysis collaboratively in all steps of the multivariable regression. Ali Syed conducted descriptive statistics. Dr. John Pugsley assisted with data curation and supervision. Ali Syed drafted all components of the manuscript. All authors reviewed various drafts and approved the final manuscript.

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and requested and obtained data from the University of Waterloo School of Pharmacy. Ali Syed created the research ethics application for the University of Waterloo Research Ethics Board. Dr. Wasem Alsabbagh assisted with data extraction, de-identification, and cleaning. Ali Syed was responsible for the study design and compiling of data. Ali Syed and Jennifer Pereira independently coded experiential evaluation comments. Ali Syed and Jennifer Pereira collaboratively conducted thematic analysis and drafted the manuscript. All authors reviewed various drafts and approved the final manuscript. All authors provided guidance on each step, edited the manuscript, and approved the final manuscript.

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Abstract

Background: Health professional programs, including pharmacy, face challenges in aligning academic training with real-world healthcare needs, affecting graduates' transition into practice. These challenges highlight the gap between theory and practice, particularly the role of experiential education in students' practice readiness. Competency-based education and training frameworks such as Entrustable Professional Activities (EPAs), help address this. While EPAs are widely used in medical education, their application in Canadian pharmacy programs remains underexplored. The University of Waterloo Doctor of Pharmacy (PharmD) program, with its co-operative (co-op) education model, provides a unique context for further research in this space.

Objectives: This research aims to assess the practice-readiness of University of Waterloo PharmD students and evaluate the utility of EPAs in measuring entry-to-practice competencies.

Methods: This thesis includes three studies. The first study examines the relationship between student grades, co-op evaluations, and success on entry-to-practice milestones, including final-year clinical rotations and the Pharmacy Examining Board of Canada (PEBC) Pharmacist Qualifying Examination (QE). The second study explores co-op and rotation preceptors' perceptions of students' practice-readiness, highlighting competencies developed through experiential education. The third study investigates students' and preceptors' perceptions of EPAs amongst traditional assessment tools used in the experiential education program.

Results: The first study identified predictors of success on clinical rotations and the PEBC QE. The second study found that both co-op and clinical rotations enhanced students' confidence, communication skills, and teamwork. Co-op provided interprofessional experience, supporting students' transition to final-year rotations focused on patient care. The third study revealed that students valued the real-world relevance of EPAs but had concerns about grading clarity and applicability in some co-op settings, particularly those not involving direct patient care. Supervisors and preceptors found EPAs practical but noted the need for training and rating consistency, and many preferred a hybrid model integrating EPAs with current tools.

Conclusion: This thesis provides insights into existing and novel assessment methods in experiential education in pharmacy and identifies factors influencing practice-readiness among PharmD students within a co-operative education program.

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Dedication

This thesis is dedicated to my parents, Mrs. Rubeena Syed and Mr. Abid Syed, who have always encouraged me to pursue every adventure, including this one.

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Table of Contents

<i>Examining Committee Membership</i>	<i>ii</i>
<i>Author’s Declaration</i>	<i>iii</i>
<i>Statement of Contributions</i>	<i>iv</i>
<i>Abstract</i>	<i>vi</i>
<i>Acknowledgements</i>	<i>vii</i>
<i>Dedication</i>	<i>viii</i>
<i>List of Figures</i>	<i>xiv</i>
<i>List of Tables</i>	<i>xv</i>
<i>List of Abbreviations</i>	<i>xvi</i>
Chapter 1 Introduction	1
1.1 Evolution of Pharmacy Education	1
1.2 Competency-Based Education and Training (CBET)	2
1.3 Conceptualizing Practice Readiness	3
1.4 Measuring Practice Readiness	3
1.5 Experiential Learning as a Strategic Component of Higher Education	4
1.6 Statement of Problem and Gaps in the Literature	5
1.7 Purpose of Thesis	7
1.8 Thesis Research Objectives	7
1.9 Thesis Research Questions	8
1.10 Thesis Outline	8
1.11 References	9
Chapter 2 Literature Review	10
2.1 Introduction	10
2.2 Disconnect Between Pharmacy Education and Modern Pharmacy Practice	10
2.2.1 Summary	15
2.3 Defining Practice Readiness and Factors Influencing It	16
2.3.1 Summary	20
2.4 Predictors of Performance in Pharmacy Education	20
2.4.1 Preadmission and Admission Variables	21

2.4.2 In-Program Academic Performance and Didactic Assessments	22
2.4.3 Milestone, Progression, and Standardized Examinations	23
2.4.4 Preparation Strategies and Student Behaviours	24
2.4.5 Experiential Performance and Advanced Predictive Models.....	24
2.4.6 Summary	25
2.5 WIL and Its Impact on Student Readiness for Practice	25
2.5.1 Evidence from Healthcare Education	25
2.5.2 WIL in Pharmacy Education	26
2.5.3 Student Contributions and Reciprocal Value of WIL	28
2.5.4 Broader Educational and Workforce Impacts of WIL	28
2.6 Summary of Literature.....	29
2.7 References	29
<i>Chapter 3 Research Methodologies.....</i>	<i>30</i>
3.1 Supplemental Methods: Chapter 4.....	30
3.1.1 Data Analysis Considerations, Statistical Assumptions, and Model Diagnostics.....	30
3.1.2 Model Development and Variable Selection Strategy	33
3.1.3 Bootstrapping and Descriptive Analytic Approach.....	34
3.1.4 Overall Methodological Limitations	35
3.2 Supplemental Methods: Chapter 5.....	36
3.2.1 Study Design and Data Sources	37
3.2.2 Data Structure (Longitudinal and Dyadic Nature).....	37
3.2.3 Data Preparation and Ethical Considerations	38
3.2.4 Qualitative Analysis and Epistemology	38
3.2.5 Role of Theory in Conceptual Framing and Analysis.....	40
3.2.6 Conclusion	41
3.3 Supplemental Methods: Chapter 6.....	41
3.3.1 Study Design and Data Sources	42
3.3.2 Longitudinal and Dyadic Nature of the Data.....	42
3.3.3 Data Preparation and Ethical Rigor	42
3.3.4 Epistemological Stance, Analytic Approach, and Method Selection.....	43

3.3.5 Role of Theory in Conceptual Framing and Analysis	44
3.3.6 Methodological Considerations	45
3.3.7 Conclusion	45
3.4 Reflexivity Statement: Chapters 5 and 6	46
3.5 References	46
<i>Chapter 4 The association between academic performance and entry-to-practice milestones within a co-operative education PharmD program</i>	<i>47</i>
4.1 Overview	48
4.2 Introduction.....	48
4.3 Materials and Methods.....	52
4.3.1 Data Collection	53
4.3.2 Data Exploration	53
4.3.3 Data Analyses.....	54
4.3.3.1 Analysis 1—The Relationship between Student Course and Experiential Education Performance with PEBC Pharmacist Qualifying Examination Performance (Part I MCQ and Part II OSCE)	54
4.3.3.2 Analysis 2—The Relationship between Didactic Courses and Co-Op Performance with Rotation Performance	55
4.3.3.3 Model Diagnostics	55
4.3.3.4 Complimentary Descriptive Analysis.....	56
4.4 Results	56
4.4.1. Analysis 1—The Relationship between Student Course and Experiential Education Performance with PEBC Exam Performance (MCQ and OSCE)	58
4.4.2 Analysis 2—The Relationship between Didactic Courses and Co-Op Performance with Rotation Performance	58
4.4.3 Complimentary Descriptive Analysis	58
4.5 Discussion.....	59
4.5.1 Limitations	64
4.6 Conclusions.....	64
4.7 References	65
<i>Chapter 5 Fostering career-readiness in pharmacy students through work-integrated learning: Qualitative analysis of co-op supervisor and rotation preceptor feedback on student performance</i>	<i>67</i>

5.1 Overview	68
5.2 Introduction	69
5.3 Methods	72
5.3.1-Study design	72
5.3.2-Data collection, study period, and sample size.....	73
5.3.3-Analysis	73
5.3.4-Research Ethics.....	73
5.4 Results	74
5.5 Discussion	82
5.6 Conclusions	85
5.7 References	85
<i>Chapter 6 Entrustable Professional Activities (EPAs) for Pharmacy Students During Experiential Education: A Comparative Analysis</i>	87
6.1 Overview	88
6.2 Introduction	89
6.3 Methodology	92
6.3.3 Data Collection	93
6.3.5 Research Ethics.....	95
6.4 Results	95
6.5 Discussion	100
6.5.1 Limitations	102
6.6 Conclusions	103
6.7 References	103
<i>Chapter 7 Discussion and Conclusion</i>	106
7.1 Overview	106
7.2 Interpretation of Findings and Gaps in the Context of Existing Research	108
7.3 Co-op Education in Pharmacy	109
7.4 Clinical Rotations and Assessment Tools	109
7.5 Co-op vs. Rotations: Complementary but Distinct	110
7.6 Predictive Models and Risk Identification	111
7.7 Career Outcomes and Long-Term Impact of Co-op	111

7.8 Strengths, Limitations and Additional Considerations	112
7.9 Implications and Future Research Directions	115
7.10 Conclusion	117
References	118
Appendices.....	127
Appendix 4A: University of Waterloo Doctor of Pharmacy Curricular Grid	127
Appendix 4B: Abbreviations	128
Appendix 4C: Inventory of Skills competencies (co-op work-term evaluation)	129
Appendix 4D: Co-op performance evaluation attributes (co-op work term evaluation)	131
Appendix 4E: High correlation coefficients between predictor variables	132
Appendix 5A: OPPCAT evaluation criteria (rotation evaluation).....	133
Appendix 5B: Co-op supervisor and rotation preceptor quote examples.....	134
Appendix 6A: EPA Assessment Tool (co-op and rotations).....	139

List of Figures

Figure A-4.1. University of Waterloo PharmD program curricular sequence

Figure B-5.1. University of Waterloo pharmacy program overview

Figure C-6.1. Student, supervisor and preceptor preferences for WIL assessment tools

List of Tables

Table A-4.1. Data utilized in multiple linear regression analyses

Table B-4.2. Statistically significant relationships for analysis 1

Table C-4.3. Statistically significant relationships for analysis 2

Table D-4.4. Course, OSCE, midpoint exam, OPPCAT and PEBC failures, and near failures by co-op performance

Table E-5.1. University of Waterloo PharmD program WIL models.

Table F-5.2. Job/practice readiness skills observed based on thematic analysis of feedback provided by co-op supervisors and rotation preceptors

Table G-6.1. University of Waterloo PharmD Program WIL Models

List of Abbreviations

APPE	Advanced Pharmacy Practice Experience
CBE	Competency Based Education
CBET	Competency Based Education and Training
Co-op	Cooperative Education
CSL	Community Service Learning
EPA	Entrustable Professional Activities
GPA	Grade Point Average
IPFC	Integrated Patient Focused Care
IPPE	Introductory Pharmacy Practice Experience
MCQ	Multiple-Choice Question
NAPLEX	North American Pharmacist Licensure Exam
OPPCAT	Ontario Pharmacy Patient Care Assessment
OSCE	Objective Structured Clinical Examination
PCAT	Pharmacy College Admissions Test
PharmD	Doctor of Pharmacy
PP	Professional Practice
PPCP	Pharmacist's Patient Care Process
QE	Qualifying Exam
UW	University of Waterloo
WIL	Work Integrated Learning

Chapter 1

Introduction

1.1 Evolution of Pharmacy Education

Healthcare education has been changing since the start of the 20th century in response to shifts in healthcare practices, technological advancements, and growing demands for specialized care.^{1,2} Contemporary healthcare practice requires professionals who can meet current and future healthcare demands by integrating scientific knowledge and skills such as clinical judgment, communication, collaboration, and adaptability across diverse practice environments.^{1,2} However, concerns persist that current health professions curricula and assessment systems may not always reflect or keep pace with the full range of capabilities required for contemporary health systems, particularly as healthcare roles continue to expand and diversify in response to dynamic healthcare demands.²

In pharmacy education, these concerns are especially salient.¹ While scientific knowledge and mastery of drug-related information remain foundational to safe and effective practice, the scope of pharmacy practice has expanded beyond traditional dispensing roles to include direct patient care, therapeutic decision-making, medication management, health promotion, and participation in interprofessional teams.^{3,4} Pharmacists are increasingly expected to manage complex medication regimens, contribute to chronic disease management, engage in shared decision-making with patients, and adapt to emerging healthcare needs.³⁻⁵ These expanded responsibilities require not only disciplinary knowledge, but also transferable skills that can be applied across novel and evolving clinical contexts.

To minimize tensions between how competencies are taught and assessed in pharmacy curricula and how they must be enacted in pharmacy practice, educators are tasked with designing curricula that are not only reflective of current practice standards but also adaptable.⁵ While educational programs may successfully assess knowledge acquisition and discrete skills, capturing whether learners can integrate knowledge, skills and professional judgement to perform effectively in real-world settings may be a challenge.² Ensuring that pharmacy graduates are equipped with the practical skills to thrive in a variety of healthcare settings requires ongoing

innovation in teaching methods and curriculum design.⁵ As such, the demand for educational reforms that integrate both theoretical and practical components have never been more urgent.

1.2 Competency-Based Education and Training (CBET)

Strengthening healthcare education through CBET is essential to ensure that healthcare professionals are competent, adaptable to healthcare demands, and able to provide high-quality care.⁶ In CBET, competencies are described as the observable and measurable components of knowledge, skills, attitudes and values expressed as actual behaviour required for effective practice within a specific context.^{2,6} In pharmacy education, CBET has emerged as a critical reform, using competency frameworks to benchmark essential expectations and competencies that pharmacy professionals entering practice must possess.^{2,6} These frameworks are used to guide curriculum design and assessment, regulate career entry, benchmark standards of practice, and facilitate expertise development.^{2,6} By linking these competencies to defined practice standards, CBET promotes improved student performance and a culture of lifelong learning and professional development.⁶

CBET departs from traditional education models by focusing on the mastery of competencies rather than the completion of courses or accumulation of credit hours.⁷ This approach integrates both theoretical knowledge and practical experience with the aim of ensuring improved alignment between curricular objectives and professional expectations, increased emphasis on applied learning, and greater transparency in assessment criteria.^{2,6,7} However, while CBET establishes what graduates should be able to do, it does not inherently specify how competence should be assessed in authentic practice settings or how readiness for unsupervised practice should be determined. Importantly, CBET does not replace the need for strong scientific foundations. Rather, it situates scientific knowledge within a broader competency framework that emphasizes application, integration, and decision-making. In pharmacy education, this has led to curricula that combine scientific instruction with clinical training, with clinical rotations now recognized as a core component of pharmacy education.^{1,8}

1.3 Conceptualizing Practice Readiness

Despite widespread adoption of CBET, practice readiness remains an inconsistently defined construct within pharmacy education and regulation, and research in this area remains relatively limited.⁹ Competence generally refers to the ability to perform specific tasks in professional settings to an expected standard, whereas practice readiness encompasses a broader capacity to function effectively as an independent professional within real-world practice environments.^{9,10} Practice readiness in pharmacy education is often conceptualized as the degree to which a graduate is prepared to meet the expectations of the pharmacy profession. Key domains commonly associated with practice readiness include clinical reasoning, communication, professionalism, and ethical decision making, as well as personal attributes such as self-awareness, time management, problem-solving, and teamwork.^{5,10,11} These attributes, skills, and competencies are developed over time and through exposure to multiple learning environments and methods including classroom-based instruction, case-based learning, simulation, and mentorship, including within practice-based settings where students can hone their abilities in real-world contexts.^{5,9,10,11}

Transitions from student to practitioner are influenced by several factors including learner and preceptor understanding of professional expectations, familiarity assessment processes, and an opportunities for progressive responsibility.⁵ This transition can be particularly challenging in healthcare environments where new graduates must quickly adapt to the demands of clinical practice. Research suggests that robust support systems, early exposure to real-world practice, and a focus on continuous skill development can significantly enhance students' perceived readiness.⁵ Despite its importance, the precise definition of practice readiness remains a topic of ongoing debate, with disagreement remaining regarding which attributes are most critical for readiness and how they should be measured, presenting an ongoing challenge for educators and regulators alike.^{2,7}

1.4 Measuring Practice Readiness

To effectively assess practice readiness, educators must evaluate a broad range of competencies that go beyond academic knowledge. Traditional assessment methods in pharmacy

education such as course assignments and exams, milestone assessments, and Objective Structured Clinical Examinations (OSCEs) provide valuable information about knowledge acquisition and performance in controlled environments.¹¹ However, literature in this space warrants caution around using such assessments as sole predictive measures for clinical performance due to large variations in the predictive strength of the relationships identified.¹¹⁻¹³ Additional challenges with traditional assessment methods may include their isolation from authentic practice contexts, emphasis on discrete skills, artificial testing conditions, and restricted opportunities to assess longitudinal performance and professional judgement.

To address these challenges, workplace-based assessment approaches have gained prominence in health professions education, particularly through the use of Entrustable Professional Activities (EPAs). EPAs may be defined as units of professional practice that can be entrusted to a learner for unsupervised execution once sufficient competence has been demonstrated.¹⁴ It is important to note that EPAs do not replace competencies, but serve a means to translate them into observable clinical tasks that integrate multiple domains of performance.¹⁴⁻¹⁶ EPAs were initially developed in medical education and have since been adapted for use in other professions, including pharmacy.¹⁴⁻¹⁶ In pharmacy practice, EPAs cover critical aspects such as patient counseling, therapeutic decision-making, and medication management, and are increasingly being incorporated into both formative and summative assessments.¹⁴ This focus on observable actions helps ensure that assessments are more reflective of a student's ability to perform in real-world settings, thereby providing a more accurate gauge of practice readiness.¹⁴ Research suggests that EPAs can support meaningful formative feedback, enhance assessor judgment, and provide a clearer link between assessment and real-world practice.¹⁴⁻¹⁶ However, implementation varies across programs, and questions remain regarding feasibility, consistency, and how EPA-based assessments compare to traditional evaluation tools in experiential settings.

1.5 Experiential Learning as a Strategic Component of Higher Education

Experiential learning is widely recognized as a critical component of health professions education, providing learners with opportunities to apply theoretical knowledge in authentic practice environments.^{1,2,8,17} Work-integrated learning (WIL) encompasses a range of

educational models that intentionally integrate academic study with workplace experience.¹⁷ In pharmacy education, WIL most commonly occurs through structured practice experiences embedded within curricula such as clinical rotations and co-operative (co-op) education placements.^{1,2,8,17} Experiential placements differ in duration, timing, supervision, and assessment approaches, but collectively aim to support the development of applied skills, professional identity, and readiness for practice. In many North American pharmacy schools, rotations that occur early in the program are termed Introductory Pharmacy Practice Experiences (IPPEs), during which students are first exposed to the transition from classroom to practice.^{18,19} IPPEs serve as preparation for Advanced Pharmacy Practice Experiences (APPEs), which are final year rotations that focus on providing advanced clinical pharmacy services and encourage the development of independent judgement.²⁰ In addition to these experiential models, co-op serves as a unique form of WIL which alternates academic learning with paid work experience to further enhance students' practical skills by allowing them to engage in diverse professional roles and gain valuable insights into the day-to-day operations of healthcare environments.^{1,21}

In Canada, pharmacy education is guided by national competency frameworks developed by the Association of Faculties of Pharmacy of Canada (AFPC) and the National Association of Pharmacy Regulatory Authorities (NAPRA).^{22,23} The Canadian Council for Accreditation of Pharmacy Programs (CCAPP) requires Canadian pharmacy schools to use the most recent NAPRA and AFPC competencies to align with their curriculum, educational outcomes, and assessments.²⁴ In addition, all Canadian co-op programs must meet criteria and be accredited by Co-operative Education and Work-Integrated Learning Canada.²⁵

1.6 Statement of Problem and Gaps in the Literature

Although experiential learning is a cornerstone of pharmacy education, important gaps remain in understanding how different experiential models contribute to student readiness for professional practice. First, limited literature exists examining relationships between experiential education models (such as IPPEs, APPEs, and co-op) and students' development of entry-to-practice competencies. Specifically, few studies have directly compared their effectiveness or explored how academic performance and workplace-based evaluations relate to objective indicators of practice readiness.

This gap is particularly significant in the Canadian context. Co-op education in pharmacy remains relatively uncommon, and the University of Waterloo (UW) Doctor of Pharmacy (PharmD) program is one of two in North America to incorporate a paid co-op model throughout the curriculum. Despite the distinctiveness of this model, there is limited evidence examining how participation in co-op education relates to key indicators of student success such as performance on the Pharmacy Examining Board of Canada (PEBC) Pharmacist Qualifying Examination (QE) or outcomes during clinical rotations. In addition, although academic metrics and experiential evaluations are routinely used to assess performance on student progression, few studies have examined the extent to which course grades and early workplace-based assessments predict performance during later clinical placements, raising questions about the predictive validity of commonly used assessment tools.

Second, beyond quantitative measures, the perspectives of key experiential stakeholders remain underexplored in the literature. Clinical supervisors and co-op preceptors play a central role in evaluating student preparedness for real-world practice, yet few studies have examined their combined perspectives on student readiness, competency development, and gaps in training. Understanding how these stakeholders assess student performance across experiential settings is essential for aligning expectations and identifying opportunities to strengthen experiential learning design.

Third, while EPAs have emerged as a promising framework for assessing readiness for independent practice, their use within Canadian pharmacy education remains limited. Moreover, there is a lack of research examining how EPA-based assessments align with or differ from traditional evaluation tools used in co-op and clinical rotations, particularly in terms of their ability to predict real-world performance outcomes. This limits understanding of the added value of EPA-based assessment frameworks in experiential pharmacy education.

Addressing these gaps through this thesis will provide a more holistic understanding of how academic performance, workplace-based evaluations, and assessment frameworks contribute to preparing practice-ready pharmacists.

1.7 Purpose of Thesis

This thesis aims to explore practice readiness of UW PharmD program students and new graduates. Specifically, this thesis investigates the relationship between students' performance in the UW PharmD program and selected entry-to-practice milestones including performance on experiential placements and the PEBC licensing examination. In doing so, this thesis seeks to identify gaps in current assessment methods and to explore the potential utility of EPAs in comparison with traditional assessment tools used in the UW PharmD program.

This thesis contributes new insights into how existing assessment data may be used to understand practice readiness among Canadian PharmD students and new graduates, and can help to identify factors associated with performance on key entry-to-practice milestones. This work includes one of the first studies to explore the role of EPAs alongside traditional assessment tools within a co-op based PharmD program. As a result, this thesis will: (1) identify potential gaps in current assessment approaches to inform curriculum improvements within pharmacy faculties, (2) highlight curricular predictors that may support earlier identification of students at risk of underperforming to enable more timely intervention, and (3) support the preparation of pharmacy graduates for diverse roles in practice by shedding light on the alignment between experiential assessment methods and entry-to-practice competency development.

1.8 Thesis Research Objectives

1. Examine the relationship between grades and evaluations in the PharmD program and success on the PEBC QE.
2. Investigate the link between grades and evaluations in the PharmD program and performance on clinical rotations.
3. Gather insights from supervisors and preceptors regarding PharmD student preparedness for practice.
4. Compare the alignment of EPAs with existing co-op and clinical rotation assessment tools to evaluate their effectiveness in measuring practice-readiness.

1.9 Thesis Research Questions

1. Do course grades and evaluations (including co-op work terms and direct patient care rotations) correlate with performance on entry-to-practice measures in pharmacy practice?
2. How would the implementation of EPAs compare to existing PharmD assessment methods in Ontario?

1.10 Thesis Outline

This thesis is composed of 7 chapters. Chapters 4, 5 and 6 are articles that have been published in peer-reviewed journals.

Chapter 2: Literature Review

This chapter expands on the background provided in Chapter 1 and sets the foundation for Chapters 3-7.

Chapter 3: Research Methodologies

This chapter serves as a supplement to each of chapters 4-6 expanding on methods used, including citations to literature that support the methods that were chosen and an explanation of why the chosen method was selected over other approaches.

Chapter 4: The association between academic performance and entry-to-practice milestones within a co-operative education PharmD program.

The results from this chapter answer research question 1 and provide a foundation for chapters 5 and 6.

Chapter 5: Fostering career-readiness in pharmacy students through work-integrated learning: Qualitative analysis of co-op supervisor and rotation preceptor feedback on student performance.

The results from this chapter answer research question 1, complements the findings in chapter 4 and provides insight into chapter 6.

Chapter 6: Entrustable Professional Activities (EPAs) for pharmacy students during experiential education: A comparative analysis.

The results from this chapter answer research question 2 and complements the findings in chapter 5.

Chapter 7: Discussion and Conclusion

This chapter summarizes the main findings, strengths, limitations, implications and future directions of the research presented in Chapters 4-6.

1.11 References

The references for this section are located at the end of Chapter 7, subsection 7.11

Chapter 2

Literature Review

2.1 Introduction

This chapter provides an overview of the literature as it pertains to key areas of pharmacy education, practice readiness and WIL that are important for understanding, interpreting, and translating the research described in this thesis. PubMed, Embase, Scopus and ERIC were searched using the following key words: pharmacy student, Doctor of Pharmacy, pharmacy graduate, pharmacy education, practice readiness, job readiness, transition to practice, preparedness for practice, grades, assessment, evaluation, entry-to-practice, competence, licensing exam, experiential education, and work integrated learning. Variations and truncations of these key words were utilized alongside combinations of “AND” and “OR” to permit greater result inclusivity. Reference lists from relevant articles were also manually searched. While most of the literature was from North America, all studies were conducted in countries with comparable educational competencies.

Four areas of the literature are reviewed and discussed below:

- Disconnect between pharmacy education and modern pharmacy practice (**Section 2.2**),
- Defining practice readiness and factors influencing it (**Section 2.3**),
- Predictors of performance in pharmacy education (**Section 2.4**), and
- The impact of WIL on student readiness for practice (**Section 2.5**)

2.2 Disconnect Between Pharmacy Education and Modern Pharmacy Practice

There is extensive literature describing common challenges universities face in preparing graduates with the skills and knowledge required to function effectively within an evolving workforce, particularly in healthcare.⁸ A consistent theme across this body of literature is the misalignment between traditional, predominantly didactic curricula and the real-world application required in contemporary professional practice.¹ In pharmacy education, this misalignment has raised concerns that current teaching and assessment approaches may not

adequately reflect real-world practice expectations, contributing to gaps in pharmacy graduate preparedness for practice and confidence including when interacting with patients, when making decisions under pressure, and when managing interpersonal conflict.²⁶ Rapidly evolving healthcare environments, coupled with the complex combination of clinical and non-clinical competencies required of pharmacists, place significant pressure on new graduates as they transition into practice.²⁶ Inadequate preparation for these realities may result in stress, reduced confidence, and difficulty adapting to workplace demands.²⁶

The expanding scope of pharmacy practice and evolving professional roles amplify the need for graduates who are competent, motivated, and prepared for a wide spectrum of responsibilities.²⁷ Preparedness for practice may be defined as “the extent to which academic institutions equip students with the knowledge, skills, attitudes, experiences, and resilience required to fulfil their professional roles.”²⁷ However, evidence suggests that current educational approaches do not consistently achieve this goal.

In a study by Wong et al., pharmacy graduate work readiness was assessed by triangulating early-career and intern self-assessments with supervising pharmacist perceptions.²⁶ While graduates perceived themselves as work-ready, supervising preceptors identified notable gaps in communication skills and confidence during patient interactions.²⁶ **This discrepancy between graduate self-perception and a workplace readiness assessment** reveals a potential disconnect between educational outcomes and real-world expectations, underscoring the need to examine how current health professional curricula prepare practice-ready pharmacy graduates.²⁶

Elshami et al. reported only fair agreement among pharmacy alumni regarding their preparedness for practice, with notable deficiencies in non-clinical competencies such as management and professional skills.²⁷ Similarly, Ameer et al. explored perceptions of preparedness among hospital pharmacists and identified a substantial gap between university training and pharmacy practice realities.²⁸ Participants attributed this gap to curricula that emphasized didactic instruction at the expense of critical thinking and practical skill development, and recommended greater focus on experiential learning and structured workplace training.²⁸ Together, these **findings reinforce concerns that pharmacy education may at times be misaligned with the complexities of modern practice.**²⁸

Ensuring practice-ready graduates is a core responsibility of pharmacy programs and is strongly emphasized by the Accreditation Council for Pharmacy Education (ACPE).²⁹ **Despite extensive education and skills training, limited evidence exists regarding how well graduates are prepared for the transition to practice.**²⁹ Weldon et al. examined national trends in perceptions of pharmacy practice preparedness among graduating pharmacy students and preceptors over a six-year period.²⁹ Although preceptors generally agreed that students were prepared to enter practice, they consistently rated graduates' readiness lower than graduates rated themselves.²⁹ These findings mirror those reported by Kairuz et al., where pharmacy preceptors expressed less confidence in pharmacy graduates' practice readiness compared to graduates' self-perceptions of their own preparedness.³⁰

These recurring discrepancies suggest that current assessment approaches may overestimate practice readiness or fail to capture competencies valued in real-world practice settings.³⁰ Further evidence of this disconnect has been reported in studies examining pharmacy graduates' confidence and ability to perform professional services.^{31,32} Waite et al. surveyed licensed PharmD graduates from two pharmacy programs in Ontario, Canada and found that while graduates felt able and confident performing most services, confidence varied by practice setting characteristics and frequency of task performance.³¹ These findings align with a commentary by O'Neill and Rajiah, which argues that fragmentation of public health and prescribing education within United Kingdom pharmacy curricula undermines practice readiness and risks producing graduates who lack confidence and competence in clinical decision-making and public health engagement.³² The authors contend that greater curricular integration through experiential learning, simulation, and interdisciplinary teaching is required to better reflect modern pharmacy practice realities.³²

Curricular reform efforts provide further insight into how educational design influences preparedness for practice.³³ Parmar et al. demonstrated that graduates from an MPharm program reported significantly higher preparedness across professional activity, interpersonal skills, and pharmaceutical service delivery if they graduated after it was reformed to have greater emphasis on active learning and integrated core subject delivery compared to those graduating following the traditional curricula.³³ These findings support the notion that active learning strategies and curricular integration may better align educational outcomes with

practice expectations.³³ Similarly, Malau-Abduli et al. investigated readiness for clinical practice among final-year medical, dental, and pharmacy students through surveys combined with interviews and focus groups to compare students' perceived preparedness across different competency domains and learning experiences.⁵ This study reported that learners felt least prepared in system-level competencies and clinical care skills, and cited heavy academic workloads and limited exposure to healthcare systems as key barriers impacting their work readiness.⁵ The authors emphasized the need for earlier exposure to healthcare system structures, stronger institutional support, and improved alignment between educational experiences and real-world environments.⁵

At a systems level, Rhoney et al. used a multistakeholder qualitative approach to examine factors contributing to stagnation in pharmacy education, comparing traditional curricula with proposed reform strategies including CBET, expanded experiential learning, curricular redesign, and professional identity development.³⁴ The analysis identified a persistent gap between educational preparation and practice demands, exacerbated by fragmented professional identity formation and resistance to curricular change.³⁴ Across stakeholder groups, practice readiness emerged as the primary shared concern, though perceptions of reform varied by role.³⁴ The authors concluded that without coordinated, system-wide reform and stronger alignment between education and practice expectations, pharmacy education will remain insufficiently responsive to evolving professional and societal needs.³⁴

Workforce analyses further highlight misalignment between pharmacy education, employer expectations, and modern practice.³⁵ Ives et al. found that pharmacists' most frequently performed tasks changed minimally over a 10-year period, despite increasing educational and accreditation emphasis on patient-centred care.³⁵ In contrast, employer-advertised skills increasingly emphasized patient care, informatics, and interprofessional collaboration, suggesting evolving expectations are not fully reflected in routine practice.³⁵ This persistence of dispensing-focused activities alongside expanding discourse around the importance of direct patient care activities underscores a discrepancy between educational priorities, accreditation standards, and real-world practice environments.³⁵ These findings suggest that pharmacy curricula and accreditation outcomes must better account for both

frequently performed tasks and employer-identified skills to ensure graduates are adequately prepared for entry-level roles.³⁵

Several studies indicate that **current pharmacy education outcomes may omit critical competencies** required for expanded and evolving practice, compounded by increasing healthcare system complexity, workforce shortages, and population ageing.^{36,37} Daugherty et al. identified multiple underemphasized competencies within existing outcomes frameworks, including conflict management, professional advocacy, empathy, quality improvement, and transitions of care.³⁶ Employers and graduates reported a need for skills beyond regulatory competencies, particularly in interpersonal and adaptive domains such as relationship-building, time management, and navigating workplace conflict.³⁶ These findings suggest that educational outcomes may not consistently reflect the realities of modern pharmacy practice.³⁶

Complementing this work, Noble et al. demonstrated how the gap between pharmacy education and practice manifests during the transition from student to practitioner.³⁷ In this study, pharmacy interns' perceptions of their transition from university to the workplace and the influence this had on their professional identity was investigated through in-depth interviews.³⁷ Findings showed that pharmacy interns entered the workforce with patient-centred professional identities shaped during university training but encountered limited opportunities to enact these identities in practice.³⁷ Interns reported difficulty reconciling workplace demands with their educational preparation and often lacked confidence and strategies to manage patient interactions, interprofessional relationships, and competing responsibilities.³⁷ This misalignment contributed to challenges in professional identity formation and perceptions of being underprepared for practice.³⁷

Employer perspectives further underscore the disconnect between educational preparation and practice expectations.³⁸ Vlasses et al. examined employer expectations of newly graduated pharmacists to inform revisions to pharmacy accreditation standards.³⁸ Results from this study found consistent expectations regarding competence in medication distribution systems, patient safety, professionalism, communication, and teamwork, with variable expectations for direct patient care involvement. While foundational clinical knowledge and problem-solving skills were valued, employers generally did not expect new graduates to function independently in advanced clinical roles without additional training.³⁸ These findings

emphasize the need for curricula to ensure baseline practice readiness aligned with entry-level responsibilities.³⁸ Murphy's commentary further contextualises these findings, arguing that while graduates consistently meet licensure standards and are well prepared for medication provision, they may not be adequately prepared for direct patient care at entry to practice.^{38,39} Murphy contended that pharmacists are underutilized for clinical care, a mismatch that may be attributed to misalignments across educational institutions, workforce expectations, and reimbursement models.³⁹ Given the increasing complexities and variability in pharmacy practice and experiential training limitations, this commentary argues that it is unrealistic to expect pharmacy education institutions to consistently produce graduates who are fully prepared to deliver direct patient care upon graduation.³⁹

At the level of experiential education, O'Sullivan and Sy identified the competencies necessary to support practice readiness among community pharmacy-bound students.⁴⁰ Despite adequate didactic preparation, gaps were found in students' ability to apply their knowledge during patient interactions and manage the competing demands of high-volume practice settings.⁴⁰ This study highlighted a **misalignment between academic preparation and experiential demands**, emphasizing the need for experiential curricula that are structured, longitudinal, and outcomes-focused, to better support entry-level readiness.⁴⁰

In parallel, McLaughlin et al. underscored the growing importance of nontechnical skills such as communication, leadership, adaptability, collaboration, and problem-solving.⁴¹ These skills are essential for pharmacists to function effectively in interprofessional teams and dynamic care models.⁴¹ This work further supports the argument that traditional curricula, which often prioritize discipline-specific knowledge and assessment, may leave graduates underprepared for the realities of contemporary practice, where nontechnical skills are just as crucial.⁴¹

2.2.1 Summary

Curricular reform in pharmacy education remains challenged by structural inertia, accreditation constraints, and misaligned stakeholder priorities.³⁴ Deeply embedded institutional systems and competing expectations can limit the pace and scope of reform, even when the need for change is widely recognized.³⁴ At the same time, pharmacy graduates, preceptors, and employers report gaps between university curricula and the realities of practice, particularly in

the development of key competencies required in contemporary healthcare settings.⁴² Evidence of misalignment is further demonstrated by discrepancies between pharmacists' daily tasks and employer-advertised skills, indicating that curricular content has not fully kept pace with evolving professional roles.⁴³ Collectively, this literature suggests that addressing the theory–practice gap requires not only curricular updates, but systemic alignment of institutional structures, stakeholder expectations, and contemporary practice demands.

Collectively, there is consistent evidence of a disconnect between pharmacy education and modern practice expectations. Although graduates meet licensure and accreditation requirements, employers, educators, and graduates themselves continue to identify shortcomings in applied skills, confidence, professional identity formation, and system-level competencies. These findings reinforce ongoing concerns regarding the preparedness of new pharmacy graduates for contemporary practice and highlight the need for curricula, assessment approaches, and experiential learning models that more closely reflect contemporary practice realities. In response to these concerns, the concept of “practice readiness” has emerged as a key lens through which pharmacy graduate preparedness is discussed and evaluated.

2.3 Defining Practice Readiness and Factors Influencing It

Within an evolving healthcare landscape, the concept of “practice readiness” remains fluid and variably defined, particularly in pharmacy.³⁶ Contemporary discourse broadly characterises a practice-ready entry-level pharmacy graduate as one who is prepared to meet complex professional challenges while engaging in lifelong learning.³⁶ However, related scholarship problematizes the overlapping terminology used to describe readiness, particularly the frequent yet undefined use of “transition to practice” in pharmacy.⁴⁴ The literature highlights ambiguity regarding whether transition to practice refers to competence at graduation, adaptation during early employment, or progressive professional identity formation, revealing conceptual overlap with constructs such as practice readiness, competence, and work readiness.⁴⁴ This lack of shared or operational definitions obscures the intended meaning of readiness for practice and reinforces the need for clearer conceptual boundaries and stronger theoretical grounding in pharmacy education discourse.⁴⁴ Across pharmacy and other health professions literature, practice readiness is increasingly conceptualized as a multidimensional and context-dependent

construct that extends beyond technical competence to include professional identity, adaptability, and social integration into practice environments.

One approach to defining practice readiness has focused on articulating professional roles and associated competencies. Daugherty et al., using a nominal group technique, identified seven core pharmacist roles central to contemporary practice, including knowledge expert, patient care provider, professional, scholar, system-based practitioner/manager, collaborator, and advocate/health promoter.³⁶ Their work also identified gaps in existing curricula, including limited emphasis on conflict management, advocacy, scholarship, empathy, transitions of care, quality improvement, and health systems knowledge.³⁶ This study suggests that defining practice readiness through professional roles and mapped competencies provides a structured, yet adaptable, framework through which pharmacy programs may refine and operationalise the concept over time.³⁶ While national competency frameworks are central to academic pharmacy programs, there is growing recognition that competencies alone may not fully capture the complexity of readiness for practice.

Discourse around defining practice readiness has also been well documented across other health professions, offering valuable comparative insights. In a qualitative study by Wolff et al., practice readiness in nursing was explored through focus groups involving nurses from practice, education, and regulatory sectors with varying levels of experience.⁴⁵ Findings demonstrated that expectations of readiness were shaped by the historical, social, and professional contexts in which nursing education and practice are embedded.⁴⁵ Differences emerged in perceptions of responsibility for readiness, the balance between technical and professional preparation, and the role of education versus practice environments in shaping competence.⁴⁵ These findings reinforce how expectations of readiness are shaped by professional context and stakeholder perspectives. This includes considering when readiness is assessed, whether upon graduation, at the start of the first job, or during the first year of practice. This temporal differentiation is essential to understanding how readiness evolves in real-world practice.

Regulatory perspectives further reveal definitional ambiguity regarding practice readiness. A scoping review by Ni Sheachnasaigh et al. examined methods used by national regulatory bodies to assess pharmacists' readiness to practise.⁹ The review identified a paucity of publicly available information regarding how regulators define or determine readiness for

practice as well as limited empirical research in this area.⁹ While other health professions have more clearly linked readiness to safe care, performance confidence, and transition into independent roles, pharmacy lacks cohesive discourse connecting readiness with competence, transition, and autonomy.⁹ This regulatory gap further contributes to conceptual uncertainty surrounding practice readiness in pharmacy.

Within pharmacy education, readiness has frequently been operationalized through assessment rather than definition. A scoping review by Howe et al. demonstrated that despite widespread assessment of APPE readiness, no standardized definition of the construct exists across schools of pharmacy.⁴⁶ This review identified substantial variability in assessed domains, ranging from knowledge and skills to professionalism, reflecting institution-specific interpretations of what constitutes practice readiness.⁴⁶ Moreover, readiness was most often evaluated through summative, end-of-didactic assessments, reinforcing an outcome-focused rather than developmental understanding of the construct.⁴⁶ Gruenberg et al. further advanced conceptual understanding by framing practice readiness as a multidimensional and socially situated construct co-produced by learners and practice environments.⁴⁷ Drawing on perspectives from students, faculty, and preceptors, this qualitative study emphasized that readiness extends beyond knowledge and technical competence to include learner attitudes, professional identity, adaptability, and capacity to engage productively within practice contexts.⁴⁷ Notably, this work challenges definitions that position readiness solely as an individual learner attribute, instead proposing readiness as a relational and contextual phenomenon.⁴⁷

Broader health professions literature reinforces the discourse regarding the concept of practice readiness. Malau-Aduli et al. explored perceptions of work readiness among medical, dental, and pharmacy students and conceptualized readiness as a multidimensional construct extending beyond academic preparation.⁵ Key themes related to readiness across all three disciplines included acquisition of knowledge and skills, value of clinical placement experiences, and support from peers, family, and staff.⁵ The findings also highlighted misalignment between curricular outcomes and students' self-assessed readiness.⁵ Similarly, a scoping review by Masso et al. demonstrated that practice readiness among new graduate nurses is framed inconsistently and influenced by intrapersonal, interpersonal, and organizational factors.¹⁰

A systematic review by McMullen et al. further noted that variability in competency frameworks and assessment approaches limits the development of a shared understanding of practice readiness.² This review suggests that without clearer articulation of how competencies signify readiness, we risk perpetuating fragmented or implicit definitions of practice readiness instead of resolving conceptual ambiguity.² Additional perspectives emphasize that practice readiness is not only defined by competencies, but also requires consideration of its experiential and contextual dimensions. In a commentary by Cox, experiential education models that prioritize the quantity of experiential hours over the quality of learning experiences were critiqued.⁴⁸ This commentary argued that increased exposure alone does not guarantee readiness for practice, highlighting the importance of intentional curriculum design, supervision, and reflection in doing so.⁴⁸

Formal conceptual analyses provide insight into the defining attributes of practice readiness. Mirza et al. conducted a concept analysis in nursing, identifying key attributes such as cognitive, professional, and clinical capabilities, along with self-efficacy.⁴⁹ Antecedents included factors such as maturity, clinical experience, and professional socialization, while consequences involved safe care provision, performance confidence, and transitions into practice roles.⁴⁹ While this analysis sheds light on the technical aspects of nursing practice readiness, it does not account for the humanistic qualities that are essential for providing quality care.⁴⁹ Le Huray et al. empirically derived a definition of readiness to practice through content analysis, identifying seven core domains consistently associated with readiness across health disciplines. These domains included personal attributes, cognitive aspects, clinical competence, social and educational experiences, professional development, and onboarding.⁵⁰ The inclusion of onboarding refers to the structured support and orientation provided to new professionals as they transition into their roles. This emphasizes the importance of structured transition support when integrating new practitioners into practice environments. Similarly, Wynne et al. systematically reviewed readiness for practice across various health professions, identifying persistent challenges with definitional inconsistency and variability in measurement.⁵¹ Despite this heterogeneity, common elements such as clinical competence, communication, ethical practice, and self-efficacy emerged.⁵¹

Applied perspectives from employers further inform the discourse. A study by Thompson et al., explored employer perspectives on characteristics valued in newly graduated pharmacists, offering an applied lens on practice readiness.⁵² Employers emphasized professionalism, communication skills, work ethic, and adaptability alongside clinical knowledge.⁵² These findings highlight differences between academic interpretations of readiness which focus on knowledge and assessment and workplace expectations.⁵² Efforts to operationalize practice readiness have also emerged. A cross-sectional study by Almarzoky Abuhussain et al, developed a work readiness scale for pharmacy interns and graduates incorporating domains such as personal attributes, organizational acumen, and professional competence.⁵³

2.3.1 Summary

Collectively, the literature demonstrates that practice readiness is widely regarded as a multidimensional, evolving construct shaped by educational preparation, learner attributes, workplace context, and social expectations. Despite growing recognition of its importance, pharmacy, like other health professions, continues to lack a shared, theoretically grounded definition of practice readiness. This definitional ambiguity complicates efforts to assess, ensure, and meaningfully compare readiness for independent practice, underscoring the need for clearer conceptual frameworks to guide future educational design and evaluation.

Given the persistent ambiguity surrounding the definition and assessment of practice readiness, pharmacy education research has increasingly relied on licensure examination performance as a proxy indicator of graduate preparedness, prompting extensive investigation into the factors that predict success on this high-stakes assessment.

2.4 Predictors of Performance in Pharmacy Education

Pharmacy licensure examinations are critical measures to ensure that pharmacists possess the necessary knowledge, skills, and competencies to practice safely and effectively in their respective countries. One such examination is the North American Pharmacist Licensure Examination (NAPLEX), a standardized test designed to assess the knowledge and competencies required for pharmacy practice in the United States.⁵⁴ Developed by the National Association of Boards of Pharmacy (NABP), the NAPLEX is used by state boards of pharmacy to evaluate candidates' knowledge, competence, and abilities in key areas of pharmacy practice.⁵⁵ It serves as

a valid and objective assessment tool, ensuring that candidates meet essential competencies in areas such as patient care, medication therapy management, pharmaceutical sciences, and systems-based practice. The exam is structured to ensure that candidates demonstrate the necessary expertise to make informed decisions, provide appropriate patient care, and contribute to the broader healthcare system.^{54,55}

While this section focuses on the NAPLEX, it is important to recognize that other countries have their own licensure examinations. In Canada, the PEBC Pharmacist QE is the standard licensure exam. It consists of a Part I Multiple-Choice Question (MCQ) exam and a Part II OSCE.⁵⁶ In the United Kingdom, pharmacists must pass the General Pharmaceutical Council (GPhC) Registration Assessment.⁵⁷ Similarly, in Australia, the Australian Written Intern Examination is used to evaluate pharmacists seeking licensure.⁵⁸

A substantial body of literature has examined predictors of performance on the NAPLEX, drawing on preadmission characteristics, in-program academic performance, milestone and progression examinations, experiential assessments, student preparation behaviours, and institutional factors.⁵⁹⁻⁸² Collectively, these studies demonstrate that while preadmission variables have modest predictive value, in-program academic performance and milestone assessments consistently emerge as the strongest predictors of NAPLEX success.⁵⁹⁻⁸²

2.4.1 Preadmission and Admission Variables

Early studies focused primarily on traditional preadmission variables such as pre-pharmacy grade point average (GPA), Pharmacy College Admission Test (PCAT) scores, and prior degree status. McCall et al. used correlation and regression analyses to examine the relationship between these variables and NAPLEX performance in a single-institution cohort.⁵⁹ Pre-pharmacy GPA and PCAT scores were modest but statistically significant predictors of NAPLEX performance, whereas demographic variables contributed limited explanatory value. Building on this work, Allen and Diaz incorporated both admissions criteria and in-program performance into their regression model and demonstrated that cumulative PharmD GPA was a substantially stronger predictor of NAPLEX outcomes than admissions variables alone, although PCAT and science GPA retained smaller independent associations.⁶⁰

Several studies have further examined demographic, cognitive, and sociological predictors of licensing examination performance. McLaughlin critically evaluated the use of demographic variables in NAPLEX predictive studies and reported that age, race, ethnicity, prior degree status, PCAT scores, pharmacy GPA, and milestone exam performance may be associated with NAPLEX outcomes, while sex and gender showed no significant relationship.⁶¹ This study argues that using demographic predictors can have unintended consequences, including the risk of reinforcing existing biases, and therefore cautions that such approaches should be applied carefully to ensure equitable opportunities for all learners.⁶¹ Non-academic admissions tools have also been explored. Cameron et al. examined the predictive validity of Multiple Mini Interviews (MMIs) for performance on the PEBC licensure examination.⁶² The MMI, designed to assess communication, motivation, and problem-solving skills, significantly predicted OSCE performance, while prior academic performance and PCAT scores also positively correlated with performance on the PEBC exam.⁶² Ware explored personality traits using the Myers-Briggs Type Indicator and found that certain personality profiles were associated with first-attempt NAPLEX score performance, suggesting that individual learner characteristics may influence success on standardized examinations.⁶³

2.4.2 In-Program Academic Performance and Didactic Assessments

Much of the literature exploring predictors of performance on the NAPLEX have focused on didactic and milestone exam performance in pharmacy curricula. In a study by Elder et al., the effect of student performance in clinical skills laboratory courses on NAPLEX success was investigated using linear regression.⁶⁴ Regression analyses revealed that while drug information responses were not predictive of total NAPLEX scores, patient case presentations and associated critical thinking questions were predictive, underscoring that students who struggle with assessments in these areas may be considered for early intervention to help improve the likelihood of success.⁶⁴ Chisholm-Burns et al. conducted a retrospective analysis examining pre-pharmacy, pharmacy school, and demographic variables, reporting that pharmacy GPA, undergraduate GPA, PCAT scores, race/ethnicity, and on-time graduation status were all associated with NAPLEX performance.⁶⁵ Similarly, a binary logistic regression analysis performed by Spivey et al. demonstrated that unsatisfactory academic performance, particularly during the first year of pharmacy school, was associated with failure to pass the NAPLEX on the

first attempt.⁶⁶ Madden et al. further identified remediation status as a significant risk indicator, with students requiring remediation being less likely to achieve first-time NAPLEX success.⁶⁷ A linear and logistic regression analysis was carried out by Shah and colleagues to identify independent risk factors for poor NAPLEX performance.⁶⁸ Independent factors associated with poor NAPLEX outcomes included older age at graduation, low PCAT, Pharmacy Curriculum Outcomes Assessment (PCOA) and High Risk Drug Knowledge Assessment scores (an internal third-year pharmacy exam assessing knowledge of commonly prescribed medications and their mechanisms, dosing, indications, adverse effects, interactions, monitoring, and contraindications), as well as multiple low course grades.⁶⁸

2.4.3 Milestone, Progression, and Standardized Examinations

The relationship between milestone examinations in pharmacy curricula and NAPLEX performance is among the most robust findings in the literature. A systematic review by Park et al. reported that potential predictors of performance on the NAPLEX were categorized into preadmission, post-admission and demographic domains.⁶⁹ This study demonstrated that milestone exams, such as the PCOA, along with cumulative pharmacy school GPA, were the most consistent predictors of NAPLEX success across included studies. While the effects of preadmission demographics demonstrated inconsistent associations with NAPLEX success, the relationship between milestone assessments and NAPLEX performance was notably stronger.⁶⁹ A meta-analysis by Daugherty and Malcom confirmed a positive correlation between third-year PCOA scores and NAPLEX outcomes, supporting the role of milestone assessments as indicators of curricular progression and readiness.⁷⁰⁻⁷⁴ Institution-specific progress and comprehensive examinations have also shown to be predictive of NAPLEX performance. Alston and Haltom provided criterion validity evidence for a second-year progress examination that identified students at risk for delayed graduation and NAPLEX failure.⁷⁵ Similarly, Rowe et al. demonstrated that an in-house comprehensive examination administered near program completion was significantly associated with both academic success and NAPLEX outcomes.⁷⁶ Karimi et al. further reported that participation in a longitudinal, integrated capstone activity contributed to a positive learning environment and may have enhanced student preparedness for the NAPLEX.⁷⁷

2.4.4 Preparation Strategies and Student Behaviours

More recent work has examined how student preparation behaviours influence licensure examination outcomes. A retrospective, qualitative analysis by Belcher et al. reported patterns of planning and preparation considerations of students with low performance on the preparatory NAPLEX exam.⁷⁸ Four major themes emerged regarding students' preparation strategies: organization and communication of study efforts, time management alongside competing obligations, prior test-taking experience, and perceived gaps in the curriculum. Although the study did not examine whether these behaviors directly influenced readiness or NAPLEX performance, the findings identify potentially actionable areas for institutions to strengthen support for preparation for both the Pre-NAPLEX and the NAPLEX licensing examination.⁷⁸ Chilbert et al. similarly found that earlier examination timing within 60 days of graduation, moderate-to-extensive preparation effort, and a cumulative GPA of 3.5 or higher were associated with first-time NAPLEX success.⁷⁹ Gupta et al. explored the relationship between active-learning activities and licensure examination outcomes and reported moderate positive correlations between grades on active-learning activities, course performance, and both NAPLEX and PCOA scores.⁸⁰ These findings suggest that pedagogical approaches promoting engagement and application of knowledge may contribute to improved performance on standardized examinations.

2.4.5 Experiential Performance and Advanced Predictive Models

Emerging evidence suggests that experiential and late-stage assessments may also contribute to predicting pharmacist licensing exam performance. In a single-center, retrospective, observational analysis by Truong et al., the correlation between APPE exam scores and licensure outcomes within one program were examined using logistic regression.⁸¹ Results from this study found that higher APPE exam performance was associated with successful licensure attainment, suggesting experiential assessments may serve as late-stage predictors. Oyler et al. applied advanced machine learning techniques to predict NAPLEX performance and demonstrated improved predictive accuracy compared with traditional regression models.⁸² Across models, pharmacy GPA, high-stakes progression exam performance, and engagement with NAPLEX preparation resources consistently emerged as the most influential predictors. This work

highlights the potential for more sophisticated analytic approaches to integrate multiple predictors and improve early identification of at-risk students.

2.4.6 Summary

NAPLEX performance is most strongly predicted by in-program academic performance, milestone assessments, and engagement with preparatory activities, while preadmission and demographic variables play a more limited and context-dependent role. Although these predictors offer valuable insight into licensure examination performance, they primarily reflect academic and assessment-based readiness, raising questions about the extent to which NAPLEX outcomes alone capture broader dimensions of practice readiness required for contemporary pharmacy practice. Despite the extensive literature identifying academic and assessment-based predictors of NAPLEX success, such measures do not fully capture the experiential processes through which students develop contextualized competence and professional identity, positioning WIL as a critical yet comparatively underexplored contributor to readiness for practice.

2.5 WIL and Its Impact on Student Readiness for Practice

As previously defined, WIL is a core pedagogical approach in healthcare education, encompassing a range of strategies and structured activities that intentionally integrate academic learning with authentic workplace experiences through a defined curriculum.^{17,83} By situating learning within real-world practice environments, WIL is designed to bridge theory–practice gaps, promote contextualized competency development, and support students’ transition into professional roles.⁸³ Across health professions education, students consistently report positive learning outcomes associated with WIL, including increased understanding of professional expectations, healthcare system demands, regulatory environments, and societal responsibilities.⁸³

2.5.1 Evidence from Healthcare Education

Foundational evidence supporting WIL originates from broader healthcare disciplines, particularly nursing education. Berndtsson et al. conducted an integrative literature review examining WIL as a pedagogical approach to integrating theory and practice during clinical placements in nursing education.⁸⁴ The review demonstrated that WIL supports the synthesis of

theoretical and experiential knowledge through diverse teaching modalities and sustained collaboration between academic educators and clinical supervisors. Reported learning outcomes included enhanced critical thinking, reflection and reflexivity, increased understanding of interprofessional teamwork, and strengthened professional identity formation. Three central facilitators of effective WIL were identified: supervisor support, diversity of instructional approaches, and close collaboration between academic and clinical educators. Despite these benefits, the authors noted a relative lack of empirical research examining WIL as a distinct pedagogical construct within nursing education. Similarly, Jantzen employed a grounded theory approach to examine how experienced registered nurses learn in workplace settings, highlighting the contextual nature of professional learning.⁸⁵ This study identified key capabilities refined through workplace learning including self-awareness, maintaining high professional standards, healthy apprehension, and holistic patient understanding. Learning was facilitated by mentorship, team-based camaraderie, and both formal and informal learning processes, particularly through iterative enquiry and problem-solving. These findings reinforce the importance of structured workplace learning environments and organizational support in fostering professional competence and readiness.

2.5.2 WIL in Pharmacy Education

In pharmacy education, WIL is primarily operationalized through IPPEs, APPEs, and co-op work terms to intentionally connect didactic instruction with authentic pharmacy practice contexts. Grice et al. highlighted that early, intentional, and interprofessional IPPE models enhance students' understanding of professional roles, improve interprofessional collaboration skills, and support the application of discipline-specific knowledge in real-world contexts.⁸⁶ Similarly, Kennie-Kaulbach et al. examined critical events occurring during IPPEs using narrative inquiry that contributed to professional identity formation.⁸⁷ Participants reported that experiential encounters fostered deeper understanding of professional autonomy, responsibility, patient-centred care, and interprofessional collaboration. Notably, first-year students focused on understanding pharmacist roles, while second-year students emphasized how to enact those roles in practice. Emotional engagement, assumption of responsibility, external validation, and preceptor guidance were identified as key mechanisms supporting identity development.

Several studies have examined IPPEs as a mechanism for applying and reinforcing curricular concepts. McDowell et al. evaluated a community pharmacy-based health and wellness IPPE focused on immunization delivery and health assessments using a pre-post self-assessment design.⁸⁸ Survey results reported significant improvements in confidence, perceived competence, and practical skills related to immunization and health screening.⁸⁸ Stanton et al. examined perceptions of very early IPPEs delivered concurrently with didactic coursework and found that both students and preceptors perceived early experiential exposure as beneficial.⁸⁹ Similarly, Taylor et al. assessed first-year PharmD students' ability to recognize and articulate components of the Pharmacists' Patient Care Process (PPCP) during IPPEs and found that students were generally able to accurately associate observed patient care activities with PPCP steps, supporting early integration of core professional frameworks.⁹⁰ Martin et al. evaluated competency acquisition during IPPEs using OSCEs administered before and after the experience.⁹¹ Results demonstrated measurable gains in communication skills, patient assessment, and clinical decision-making, providing objective evidence that IPPE participation contributes to competency development.⁹¹

APPEs represent a more immersive form of WIL, in which students contribute meaningfully to patient care and healthcare teams. Evidence across APPE settings indicates that students engage in medication reviews, patient education, medication therapy management, geriatrics care, and interprofessional collaboration while developing applied clinical skills and professional confidence.⁹²⁻⁹⁶ Donohoe et al. assessed changes in pharmacy students' knowledge, skills, and self-efficacy after completing an APPE in geriatrics through pre- and post-knowledge tests, skill assessments, and self-efficacy surveys, finding improvement in students' geriatric pharmacotherapy knowledge, clinical skills, and self-efficacy.⁹² Similarly, Isaacs et al. further reported that APPE participation was associated with higher-order learning outcomes, including increased metacognitive awareness related to planning, monitoring, and evaluating learning, which is essential for lifelong professional development.⁹³ Parker et al., similarly found that APPE participation led to increased student self-confidence in delivering medication therapy management services.⁹⁴

While APPEs offer a close approximation of real-world practice, their role as a summative assessment of practice readiness may be limited. Although APPEs provide valuable

hands-on experience, they still occur within a structured learning environment, which may not fully replicate the complexities and responsibilities of independent practice.

2.5.3 Student Contributions and Reciprocal Value of WIL

Beyond student learning, APPEs have been shown to provide reciprocal value to practice sites. Mead et al. demonstrated that APPE students contributed substantially to a family medicine residency program through medication reviews, patient education, and interprofessional activities, with physicians and patients receptive to student recommendations.⁹⁵ A descriptive study by Smith et al. reported that APPE-level students participating in an international medical mission were capable of making a substantial number of independent clinical recommendations, underscoring their readiness to contribute across diverse practice settings.⁹⁶ Rodgers et al. further found that students perceived their value at APPE sites to include workload support, patient education, and quality improvement activities, alongside personal learning gains through self-reported questionnaires.⁹⁷

2.5.4 Broader Educational and Workforce Impacts of WIL

WIL has also been linked to broader educational, workforce, and social outcomes. In a study by Lea et al., a comprehensive training program for hospital-based pharmacists using active and WIL approaches was evaluated using a mixed-methods approach, which reported improvements in professional confidence within hospital practice contexts.⁹⁸ Choi et al., using contribution analysis, demonstrated that WIL plays a significant role in consolidating knowledge and fostering professional identity formation across health professional programs.⁹⁹ Experiential education has also been identified as a mechanism for addressing gaps between curricular instruction and real-world practice demands, particularly in communication skills.¹⁰⁰ Support structures embedded within WIL, such as coaching programs, have been shown to promote reflection, goal setting, and navigation of workplace learning challenges.¹⁰¹ Additionally, WIL experiences may enhance learner awareness of social and contextual determinants of health through engagement with underserved populations, contributing to health equity education.¹⁰²

WIL plays a critical role in supporting professional identity formation, contextualized competency development, and readiness for practice across healthcare education. In pharmacy education specifically, IPPEs and APPEs facilitate the application of curricular knowledge,

development of clinical and metacognitive skills, and meaningful participation in patient care and interprofessional teams. While evidence consistently supports the educational value of WIL, variability in structure, assessment, and outcomes measurement highlights the need for more systematic evaluation of how WIL contributes to practice readiness.

2.6 Summary of Literature

Practice readiness is widely characterized as a complex, multidimensional, and context-dependent construct that remains inconsistently defined and operationalized across educational, regulatory, and practice domains. The absence of a shared conceptual framework has contributed to fragmented discourse and an overreliance on proxy indicators of readiness, most notably licensure examination performance.

A substantial body of research has examined predictors of licensing exam success, with robust evidence linking cumulative academic performance and milestone assessments to licensure outcomes, particularly for the NAPLEX. Literature on WIL consistently demonstrates positive impacts on student learning, professional identity development, confidence, and applied competence, though it remains underrepresented in studies connecting educational experiences to downstream indicators of practice readiness and workforce preparedness.

The literature reviewed in this chapter suggests that while pharmacy education successfully prepares students in areas such as foundational knowledge and technical skills, there remain challenges in bridging the gap between academic training and the real-world expectations of contemporary pharmacy practice, particularly related to confident decision-making and adaptability. Additionally, gaps persist in the examination of cooperative education models, longitudinal experiential exposure and Canadian pharmacy education contexts. These insights inform the present research, by providing new insights into the effectiveness of existing assessment methods in Canadian PharmD programs and identifying key factors influencing practice-readiness in PharmD students and new graduates.

2.7 References

The references for this section are located at the end of Chapter 7, subsection 7.11

Chapter 3

Research Methodologies

3.1 Supplemental Methods: Chapter 4

This supplemental chapter provides a detailed justification of the methods used in **Chapters 4-6**. Specifically, it outlines: (1) statistical assumptions and diagnostic procedures, (2) processes used to determine inputs for final regression models, (3) the rationale for and implementation of a bootstrapping approach, (4) the rationale for conducting descriptive analyses of selected performance variables, and (5) the limitations associated with the methodological approaches used. Citations to relevant methodological literature and guidelines are included to support the analytic decisions made and to explain why these approaches were selected over alternative methods.

3.1.1 Data Analysis Considerations, Statistical Assumptions, and Model Diagnostics

Across the ten multiple linear regression models, all primary outcome variables including PEBC MCQ, PEBC OSCE, rotation Ontario Pharmacy Patient Care Assessment (OPPCAT) 1–3 scores, and Pharm 430, 440, and 450 rotation course grades were treated as continuous variables. Multiple linear regression was selected as the primary analytic approach, consistent with standard statistical practice for modeling continuous outcomes and estimating adjusted associations between predictors and outcomes.¹⁰³ Linear regression has been widely used in pharmacy education research to examine predictors of licensure examination performance and clinical competency, including analyses involving course grades, OSCEs, experiential assessments, and cumulative academic indicators.^{11,13,59,60,62,64,66,68,70,74,104-111}

The initial dataset included student identifiers from the 2017–2019 cohorts, predictor variables comprised of both numerical variables (e.g., course grades, Years 1–4 OSCE scores, midpoint MCQ assessment scores, rotation OPPCAT scores, and co-op inventory of skills average work-term scores) and categorical variables (e.g., graduation year, Pharm 126 [credit/no credit], and cooperative education and career action [CECA] work-term ratings categorized as

marginal, satisfactory, good, very good, excellent, or outstanding). All outcome variables were analyzed using multiple linear regression models.

Missing data were present across domains including course grades, OSCE scores, co-op evaluations, rotation OPPCAT scores, midpoint MCQ assessments, and PEBC MCQ and OSCE data. Excluding co-op variables, the proportion of missing data did not exceed 3%, a level generally considered minimal and unlikely to meaningfully bias regression estimates.¹⁰³ Missing co-op data were more substantial and primarily attributable to program structure allowing for variability in co-op work sites and job descriptions, variable work-term sequencing, and individual student circumstances. Despite efforts to retrieve missing information, some data remained unobtainable. Nine students (three per cohort) lacked PEBC outcome data and were excluded from model fitting. Following these exclusions, final analytic datasets were defined separately for each regression model. Variables with excessive missingness ($\geq 20\%$), particularly within co-op and rotation domains, were reconstructed where feasible to reduce bias while preserving interpretability.

The validity of linear regression relies on several key assumptions: linearity of relationships between predictors and outcomes, independence of errors, homoscedasticity, approximate normality of residuals, and limited multicollinearity among predictors.¹⁰³ All fitted models underwent formal diagnostic evaluation prior to interpretation. Linearity and homoscedasticity were assessed using residuals-versus-fitted-value plots. Random scatter of residuals around a horizontal reference line without systematic patterns was observed, suggesting no major violations of these assumptions. Normality of residuals was evaluated using normal Q-Q plots and residual distribution plots; residuals closely followed the reference line, indicating approximate normality and adequate model fit, and no obvious violations of the linear model assumptions.¹⁰³

Multicollinearity was assessed using the Variance Inflation Factor (VIF), which quantifies the extent to which a predictor is linearly related to other predictors in the model. VIF values exceeding 5 are commonly interpreted as indicating problematic multicollinearity.¹⁰³ In this analysis, most VIF values were below the commonly used threshold of 5, suggesting limited multicollinearity among the predictors. Two variables, Pharm 329 (VIF = 5.62) and Pharm 229

(VIF = 5.33), slightly exceeded this threshold. The correlation between these predictor variables was 0.53, indicating a moderate level of association. Because these VIF values only marginally exceeded the threshold and the correlation between the variables was moderate rather than high, both predictors were retained in the model. Collectively, the diagnostic results suggest that multicollinearity was not severe and that the primary assumptions of linear regression were reasonably satisfied, supporting the validity of the fitted models.

Correlation matrices were also examined to identify highly correlated predictors, with correlations greater than $r = 0.7$ considered indicative of high collinearity. Several course pairs, particularly those within the Integrated Patient Focused Care (IPFC) series and anatomy and physiology courses demonstrated strong positive correlations, potentially reflecting content overlap and/or similar instructional approaches. For example, Anatomy and Physiology II was positively correlated with Anatomy and Physiology I, Pharmaceutics II, and Medicinal Chemistry/Toxicology and Pharmacology, all of which are required Year 1 courses. IPFC courses were positively correlated with one another, professional practice (PP) courses correlated positively with their corresponding OSCE scores, and Pharm 450 correlated positively with its associated OPPCAT assessment.

High correlation coefficients between predictor variables	
Predictor Variables	Correlation Coefficients and p-values
Pharm 111 (Anatomy and Physiology 2)	
Pharm 110 (Anatomy and Physiology 1)	$r(328)=0.81, p<0.01$
Pharm 125 (Pharmaceutics 2)	$r(328)=0.71, p<0.01$
Pharm 141 (Medicinal Chemistry, Toxicology and Pharmacology)	$r(328)=0.72, p<0.01$
Pharm 221 (Integrated Patient Focused Care 2)	
Pharm 220 (Integrated Patient Focused Care 1)	$r(328)=0.73, p<0.01$
Pharm 320 (Integrated Patient Focused Care 5)	
Pharm 223 (Integrated Patient Focused Care 4)	$r(328)=0.73, p<0.01$
Pharm 321 (Integrated Patient Focused Care 6)	$r(328)=0.76, p<0.01$
Pharm 323 (Integrated Patient Focused Care 7)	$r(328)=0.73, p<0.01$
Pharm 321 (Integrated Patient Focused Care 6)	
Pharm 223 (Integrated Patient Focused Care 4)	$(r(328)=16.29, r=.72)$
Pharm 320 (Integrated Patient Focused Care 5)	$(r(328)=18.80, r=.76)$
Pharm 228 (Professional Practice 3)	
Year 1 OSCE SCORE	$(r(328)=22.52, r=.78, p<0.01)$
Pharm 329 (Professional Practice 5)	
Year 3 OSCE SCORE	$(r(328)=24.02, r=.8, p<0.01)$
Pharm 450 (Clinical Rotation 3)	
Rotation 3 OPPCAT	$(r(328)=18.46, r=.71, p<0.01)$

Term average variables were found to exhibit high collinearity with individual course grades. Including both term averages and individual grades in the same model would compromise coefficient interpretability and inflate standard errors. Consistent with standard recommendations for managing collinearity in regression analysis, all term average variables were excluded from the final models.¹⁰³ These steps were taken to proactively address potential concerns regarding multicollinearity, as failure to do so can lead to unstable coefficient estimates and inflated standard errors, even when overall model fit appears adequate.¹⁰³

Original co-op inventory of skills assessments included nine variables per identifier, capturing communication, distribution, and direct patient care competencies across three work terms. Due to program structure and variability in experiential exposure, not all competencies were observed during each work term, resulting in uneven missingness across students. To preserve meaningful information while reducing missing data, three composite variables including co-op communication, co-op distribution, and co-op direct patient care were constructed by averaging available scores across work terms. This approach is consistent with common practices in educational research when repeated measures are unevenly observed and when the goal is to summarize overall competency development rather than term-specific performance.¹⁰³

Pharm 126 (pharmaceutical calculations) was excluded from regression models due to extreme imbalance between credit and no-credit outcomes, which would yield unstable and non-informative coefficient estimates. Similarly, CECA overall work-term ratings were collapsed into four ordered categories (good and below, very good, excellent, outstanding) due to sparse observations in the marginal and satisfactory categories. Numeric scores from 1 to 4 were assigned to these categories for regression purposes, acknowledging the ordinal nature of the data while prioritizing model stability and interpretability.

3.1.2 Model Development and Variable Selection Strategy

Given the number of candidate predictors relative to sample size, inclusion of all variables in a single model would increase the risk of overfitting and reduce interpretability. Backward stepwise selection based on Akaike Information Criterion (AIC) was therefore used to

develop parsimonious models.¹¹² This approach begins with a full model and sequentially removes predictors that do not meaningfully improve model fit.¹¹² Backward selection was chosen over forward selection because it allows all candidate predictors to be evaluated jointly before elimination, which is advantageous when predictors are conceptually related.¹⁰³ No definitive evidence exists to suggest that one stepwise approach consistently outperforms another across applied regression contexts.^{103,112} Therefore, the choice of regression model was guided by interpretability and consistency with prior pharmacy education research that has used regression-based approaches to identify predictors of academic and licensure examination performance.^{59,60,62,64,66,68,74,104-107,59,60,64,66,74}

The primary objective of this modeling strategy was to identify and emphasize predictors demonstrating statistically meaningful associations with response variables while minimizing noise introduced by non-informative or highly correlated variables. Backward selection facilitates this objective by beginning with a comprehensive model and systematically removing predictors that do not contribute materially to model fit, thereby yielding more interpretable coefficient estimates without sacrificing explanatory power.^{103,112}

To avoid excluding variables with strong theoretical, curricular, or accreditation relevance, a predefined set of “critical” predictors was retained regardless of stepwise elimination. These included IPFC courses (Pharm 220, 221, 222, 223, 320, 321, 323, 324, 422), PP courses (Pharm 129, 130, 228, 229, 329, 330), pharmacokinetics (Pharm 224), Years 1–4 OSCE scores, midpoint MCQ scores, rotation 1–3 OPPCAT scores, and co-op variables (with adjustments as described above). Selection was informed by: (1) published literature demonstrating associations between these assessment types and entry-to-practice outcomes,^{11,13,59,60,62,64,66,68,70,74,104,105} (2) required curricular components within the PharmD program,^{21,113} and (3) competencies tested by the PEBC exam.⁵⁶

3.1.3 Bootstrapping and Descriptive Analytic Approach

Certain co-op and at-risk performance indicators exhibited highly skewed distributions, were measured using Likert-type scales, and included a very small number of poorly performing students. Under these conditions, regression-based inference is limited, as parameter estimates may be unstable and disproportionately influenced by a small number of observations.¹⁰³ In the

absence of access to external datasets for validation, bootstrapping was used as an internal resampling strategy to approximate variability that might be observed across comparable samples, thereby providing insight into the stability of regression estimates under conditions of imbalance and limited sample size.¹¹⁴

Following regression modeling and bootstrapped sensitivity analyses, a small number of rare performance cases remained insufficiently represented for reliable inferential modeling due to extreme skewness and sparse category counts, conditions under which standard regression assumptions are violated and parameter estimates become unstable.^{103,115} Rather than excluding these observations as statistical outliers, a descriptive analytic approach was implemented to document their characteristics and situate their performance within the broader dataset. Given the insufficient sample sizes to support formal hypothesis testing, descriptive analyses allowed for identification and contextualization of marginal or satisfactory co-op performance within the broader student population, without overstating statistical certainty or implying predictive relationships.^{103,116}

It is important to note, however, that descriptive analyses do not permit causal inference and should not be interpreted as evidence of association or prediction.¹⁰³ Findings based on small cell sizes are inherently sensitive to sampling variability and may not generalize beyond the observed cohorts.¹¹⁵ Additionally, the use of Likert-scale measurements limits precision and may obscure meaningful variability within response categories, a limitation that is explicitly acknowledged to avoid overinterpretation.¹¹⁷ By reporting these cases descriptively, the analysis preserves their contribution to understanding student performance while maintaining methodological transparency when inferential techniques are insufficient to meaningfully evaluate rare but educationally significant observations.

3.1.4 Overall Methodological Limitations

This study does not establish causal relationships between predictors and response variables. Data were limited to academic and assessment-based variables and did not include students' demographic, psychosocial, or pre-admission characteristics. Averaging co-op competency scores across work terms may attenuate variability in experiential learning and

obscure term-specific effects. Despite these limitations, the methods employed reflect a balance between analytic rigor and transparency given the structure of the available data.

3.1.5 Conclusion

The statistical methods used in this study were selected to balance rigor, interpretability, and transparency within the constraints of a single-institution educational dataset. Regression modeling, supported by diagnostic evaluation and bootstrapping, enabled identification of meaningful predictors of PEBC and PharmD rotation performance, while descriptive analyses ensured that rare but important performance patterns were not obscured. Together, these approaches are consistent with established statistical guidance and the broader pharmacy education literature.

3.2 Supplemental Methods: Chapter 5

Qualitative inquiry is well suited to capturing meaning, nuance, and variation through analysis of written documents, open-ended responses, and direct quotations.¹¹⁸ Qualitative methods are particularly appropriate when the goal is to illuminate program processes and outcomes that can inform decision-making about educational programs.¹¹⁸ **Chapter 5** employed a qualitative analytic approach to examine written performance feedback provided by co-op supervisors and rotation preceptors for UW PharmD students.

Qualitative methods were selected because the primary aim was to understand how practice readiness and professional skills were described and differentiated across experiential learning contexts, rather than to measure predefined competencies.¹¹⁸ Specifically, the study sought to capture how supervisors and preceptors perceived students' preparedness for practice in their own words. Although no formal theoretical framework was applied deductively during analysis, the study was conceptually informed by established theories of experiential learning and professional development. These theories shaped the focus of the research questions by foregrounding practice readiness, professional skills, and skill development across experiential contexts. Theory therefore functioned as background conceptual orientation rather than as an

analytic template, informing what phenomena were examined without prescribing how data were coded or interpreted.

3.2.1 Study Design and Data Sources

A qualitative secondary analysis was conducted using retrospective student performance feedback drawn from three institutional evaluations: (1) the Inventory of Skills Evaluation, (2) the Co-op Performance Evaluation, and (3) the PharmD rotation OPPCAT. The dataset comprised open-ended written comments provided by supervisors and preceptors for PharmD students graduating from the 2017-2019 cohorts (approximately 120 students per cohort). Bounding qualitative inquiry by time, setting, and program context strengthens credibility and analytic focus.¹¹⁹

Consistent with Patton's discussion of purposeful sampling in qualitative research, the dataset was considered information-rich because it captured authentic supervisor and preceptor perspectives on student performance across multiple experiential settings through open-ended responses.¹¹⁸ As the most elementary form of qualitative data, direct quotations helped reveal respondents' experiences and basic perceptions.¹¹⁸ Although the data were not originally generated for research purposes, careful document review allowed for systematic analysis of personal perspectives and evaluative judgments relevant to the phenomenon of practice readiness.¹¹⁸ In general, qualitative findings are longer, more detailed, and variable in content, which makes analysis inherently challenging because responses are neither systematic nor standardized.¹¹⁸⁻¹²⁰ Additional limitations include variability in respondents' writing skills and the inability to probe or extend responses.¹¹⁸⁻¹²⁰

3.2.2 Data Structure (Longitudinal and Dyadic Nature)

Although analyzed retrospectively, the dataset has an inherent longitudinal component. Feedback was analyzed over multiple experiential learning points over time, allowing examination of how skills and professional competencies evolve and how they were reinforced and emphasized across different stages of training. Longitudinal qualitative data enable researchers to explore development as a process rather than as a static outcome, which is particularly relevant in professional education contexts.^{118,119,121} The data are also dyadic in

nature, reflecting relational assessments between students and their supervisors and preceptors.¹²² Dyadic qualitative data capture evaluations that are co-constructed within professional relationships and situated practice contexts, rather than representing isolated individual perspectives.^{120,122} Such data are especially valuable in health and educational research because they illuminate how expectations, judgments, and learning outcomes emerge through interaction and shared work environments.^{120,122} Recognition of the data structure informed analysis, particularly when examining complementary, overlapping, or asynchronous descriptions of skill development across experiential contexts.^{120,122}

3.2.3 Data Preparation and Ethical Considerations

Prior to analysis, all datasets were fully de-identified by individuals not involved in coding or interpretation to protect confidentiality and minimize the potential for implicit bias during analysis. This approach aligns with Patton's emphasis on ethical rigor, reflexivity, and analytic neutrality when working with institutional performance data.¹¹⁸

3.2.4 Qualitative Analysis and Epistemology

Chapter 5 followed an inductive qualitative approach, meaning that codes and themes were derived from the data rather than imposed *a priori*. Inductive analysis allowed the research team to engage closely with the data to discover important patterns, themes, and interrelationships, and was selected to align with the exploratory aims and secondary nature of the dataset, which is appropriate when existing theories may not fully capture practice-based variation.¹¹⁸⁻¹²⁰ It is important to note that while inductive reasoning may be prone to certain logical limitations, the data derived from this approach can still be used with reasonable confidence, though conclusions should remain open to further scrutiny in the development of new knowledge.¹²⁰ From this perspective, inductive analysis enables patterns to emerge from repeated observations across the dataset, producing findings that are not claimed as definitive, but as credible, contextually grounded, and useful for understanding practice readiness in this research context.^{118,120}

Ontologies are beliefs about the basic entities that make up reality and concern the essential phenomena researchers can expect to find empirically.¹²⁰ The ontology of realism holds

that the world possesses qualities that exist independently of our ideas and are empirically accessible, such that data can correspond directly to those qualities without bias from researchers' perspectives and values.¹²⁰ Ontologically, **Chapter 5** is situated within a realist-pragmatic epistemological orientation.¹¹⁸⁻¹²⁰ This stance assumes that supervisors' and preceptors' written feedback reflects real judgments and experiences situated within authentic educational and workplace contexts, while acknowledging that these accounts are shaped by institutional norms, evaluative purposes, and professional expectations.¹²⁰ Pragmatism emphasizes that practical problems determine how phenomena are studied and prioritizes methodological choices based on what best addresses the research question within a given context, rather than adherence to a single theoretical framework.¹¹⁸⁻¹²⁰ Within health professions education, pragmatic qualitative inquiry supports the use of multiple credible methodological approaches and facilitates the generation of findings that are accessible and actionable for relevant stakeholders.¹¹⁸⁻¹²⁰

Two members of the research team independently coded a randomly selected sample of comments to develop an initial inductive codebook. This process supported reflexive comparison of interpretations and facilitated the development of shared analytic meaning. The remainder of the dataset was then coded using the agreed-upon codebook, with each coder independently analyzing half of the data. Throughout the analytic process, the researchers engaged in ongoing dialogue to refine codes, add sub-codes, and resolve interpretive discrepancies. Themes and sub-themes were identified through examination of relationships among codes, consistent with Patton's description of inductive analysis as immersion in the data followed by pattern recognition and creative synthesis.¹¹⁸ Consensus was achieved through discussion rather than statistical measures of inter-rater reliability, aligning with qualitative traditions that prioritize interpretive depth, reflexivity, and shared understanding over quantification.^{118,120}

Given the secondary, bounded nature of the data and the applied, exploratory aims of the study, thematic analysis was selected over methodologies requiring theoretical sampling or iterative data generation such as grounded theory.¹¹⁸⁻¹²⁰ Thematic analysis focuses on identifying and interpreting patterned meaning across a bounded dataset without the requirement to generate a formal explanatory theory.¹¹⁸⁻¹²⁰ Further, this study intentionally employed inductive rather than deductive analysis. Deductive approaches apply pre-existing theoretical frameworks to

guide coding, interpretation, and hypothesis testing, requiring analytic categories to be specified prior to data analysis.¹¹⁸⁻¹²⁰ In contrast, inductive analysis allows analytic dimensions to emerge from the data through close engagement and iterative interpretation,¹¹⁸⁻¹²⁰ which is better aligned with the aim of this research.

3.2.5 Role of Theory in Conceptual Framing and Analysis

There is a distinction between qualitative methodological frameworks, which provide structured procedures for data analysis, and theory, which functions as a way of explaining phenomena by providing conceptual scaffolding for understanding how and why observed patterns occur.¹¹⁸⁻¹²⁰ In this study, theory informed the conceptual framing of the research questions and the interpretation of findings but did not function as a deductive analytic framework during coding. Established theories of experiential learning and professional development, such as Kolb's Experiential Learning Theory and Lave and Wenger's Situated Learning and Communities of Practice theories provide frameworks for understanding how learners progress through stages of skill acquisition, reflection, and increasing independence.¹²³⁻¹²⁵ The patterns observed in **Chapter 5** align broadly with these theoretical constructs.^{118-120,123-125} This study was therefore designed with awareness of these theories and ensured that core components of professional skill development and practice readiness were meaningfully analyzed in the data.¹²³ This decision was made to avoid constraining interpretation and to allow pre-existing institutional feedback to speak for itself.

Theory-free does not mean theory-ignorant, rather, it reflects a strategic choice to prioritize emergent meaning when working with applied program data and exploratory research questions.¹¹⁸ Upon reflection, the findings suggest that the progression of students from observation to supervised practice to independent decision-making, along with patterns of reflective learning, are consistent with the stages described in the aforementioned theories.¹²³⁻¹²⁵ Had a deductive framework been applied, it would have shaped coding decisions and interpretation differently, potentially narrowing analytic focus. While theoretical frameworks are valuable tools for structuring inquiry and interpreting findings, an inductive pragmatic approach was deemed appropriate given the secondary nature of the data, the absence of theoretical sampling, and the exploratory aims of the analysis.¹¹⁸⁻¹²⁰

3.2.6 Conclusion

This study prioritized methodological rigor and analytic coherence, limiting deductive theoretical imposition during analysis. The inductive thematic methods allowed for a rich description of practice readiness and skill development across experiential contexts, while leaving space for future research to explicitly test, refine, or extend theoretical models using deductive designs. Qualitative rigor is not dependent on the explicit use of theory alone, but on alignment among research questions, data sources, analytic approach, and ontological and epistemological stance.^{119,120} The pragmatic, inductive thematic approach used in this study reflects such alignment and supports the credibility, transferability, and applied relevance of the findings within health professions education.

3.3 Supplemental Methods: Chapter 6

This chapter employed a convergent mixed-methods survey design to examine perceptions of EPAs among PharmD students and their co-op supervisors and rotation preceptors. The purpose was to evaluate the perceived utility of EPAs relative to existing experiential education assessment tools, with particular attention to feasibility, interpretability, and perceived value in practice-based assessment contexts. Mixed methods were selected because the research questions required both descriptive quantification of participant perceptions and qualitative exploration of how and why EPAs were experienced as useful or challenging in practice, and because neither approach alone would sufficiently capture perceived patterns and implementation nuance. Creswell describes mixed-methods research as particularly appropriate when neither quantitative nor qualitative approaches alone sufficiently address the complexity of a research problem and when integration of numeric trends with narrative explanation enhances interpretive validity.¹¹⁹ Although no formal theoretical framework was applied deductively during analysis, the research questions were conceptually informed by Competency-Based Education, Situated Learning, and Communities of Practice theories, which together articulate how competence develops in context, how autonomy is conferred progressively, and how learners advance from novice to proficient practitioner through experience and reflection.¹²⁴⁻¹²⁷ These theories informed attention to feasibility, interpretability, supervision, and perceived value

of EPAs in practice-based assessment contexts. Therefore, theory guided what was examined in the study, while analytic procedures remained inductive and grounded in participant responses.

3.3.1 Study Design and Data Sources

In this research context, mixed methods supported triangulation across data types while maintaining sensitivity to participant experience, consistent with Patton's pragmatic approach to evaluation research.¹¹⁸ From a qualitative perspective, the methods produced a wealth of detailed information from a relatively small number of participants, increasing depth of understanding, with the caveat of reduced generalizability.¹¹⁸ This dual focus aligns with applied evaluation research aimed at illuminating program effectiveness and informing decision-making within organizations.¹¹⁸

3.3.2 Longitudinal and Dyadic Nature of the Data

Data were collected at midpoint and end-of-term, across both co-op and rotation placements. This design introduced a longitudinal component, allowing examination of how perceptions of EPAs evolved over the term. Longitudinal approaches are especially valuable in educational research because they capture shifts in understanding, judgment, and familiarity that occur as participants gain experience with an assessment tool.^{118,120,121} The study was intentionally designed around dyads, defined as paired student-supervisor or student-preceptor relationships.^{120,122} Dyadic enrollment ensured that perspectives on EPAs were grounded in shared assessment experiences rather than isolated viewpoints.^{120,122} Dyadic designs are particularly valuable in health professions education research because assessment practices are inherently relational, emerging through interaction, supervision, and shared clinical work across a student and instructor.^{120,122}

3.3.3 Data Preparation and Ethical Rigor

All data were de-identified prior to analysis by an individual external to the research team in alignment with Patton's emphasis on minimizing analytic bias and protecting participant confidentiality in evaluative research involving performance data.¹¹⁹

3.3.4 Epistemological Stance, Analytic Approach, and Method Selection

Ontologically, the analysis reflects a pragmatic-realist stance, assuming participant accounts represent meaningful insights into actual assessment practices while recognizing that these accounts are shaped by institutional norms, professional roles, and assessment culture.¹¹⁸⁻¹²⁰ Pragmatic inquiry accepts that knowledge is provisional and context-dependent, valuing findings for their practical utility rather than for claims of objective certainty.¹¹⁸⁻¹²⁰

Quantitative survey data were analyzed descriptively to summarize participant perceptions of EPAs relative to existing assessment tools. Descriptive statistics were selected because the quantitative aim was not hypothesis testing, but characterization of patterns and distributions across participant groups.¹¹⁹ Creswell notes that in mixed-methods research, quantitative components need not be inferential to be rigorous.¹¹⁹ Descriptive analyses can play a critical role in contextualizing qualitative findings and identifying trends that warrant deeper exploration.¹¹⁹ In this study, quantitative results served to complement qualitative interpretation rather than serve as standalone evidence. An inductive approach was selected to allow participants' experiences and judgments regarding EPAs to emerge without imposing predefined evaluative criteria.¹¹⁸⁻¹²⁰ This approach is particularly appropriate when evaluating new or evolving tools in applied educational settings, where real-world use may differ from intended design and where exploratory understanding is prioritized over theoretical testing.

Two members of the research team independently coded a portion of qualitative responses to develop an initial inductive coding dictionary. This process enabled reflexive comparison of interpretations and enhanced analytic transparency.¹¹⁸⁻¹²⁰ The remaining data were coded using the agreed-upon dictionary, with ongoing consultation to refine codes and resolve discrepancies. Rather than relying on statistical inter-rater reliability, disagreements were resolved through discussion until consensus was reached. This approach aligns with qualitative traditions that prioritize interpretive coherence, reflexivity, and shared meaning-making over numerical agreement.¹¹⁸⁻¹²⁰ Codes were subsequently organized into themes and sub-themes reflecting perceived strengths, limitations, and comparative utility of EPAs.

The analytic approach aligns with thematic analysis as described by Braun and Clarke.¹²⁸ Thematic analysis focuses on identifying patterns within a bounded dataset to address specific

research questions, whereas other approaches including grounded theory seek to generate new theory through iterative data collection, theoretical sampling, and constant comparison.¹¹⁸⁻¹²⁰ Thematic analysis is therefore aligned with the nature of the research question and its novelty, and is suitable for mixed-methods designs using survey-based qualitative data.

3.3.5 Role of Theory in Conceptual Framing and Analysis

In this study, Competency Based Education, Situated Learning, and Communities of Practice theories guided the conceptual framing of EPAs and the development of survey content, but was not used as a deductive framework to structure qualitative coding or quantitative interpretation.¹²⁴⁻¹²⁷ Theory serves as an explanatory scaffold by offering ways to understand how and why observed patterns occur.¹¹⁸⁻¹²⁰ EPAs themselves are grounded in theories of competency-based education, professional trust, and progressive independence. This chapter ensured that core theoretical components of EPAs such as supervision, entrustment and progression were meaningfully represented in data collection. However, a formal theoretical framework was not explicitly applied during qualitative analysis. This decision reflected a pragmatic choice to prioritize participant experience and applied utility over theoretical testing. As Patton emphasizes, evaluation-oriented research may be theory-informed without being theory-driven, particularly when the primary goal is understanding implementation and perceived value in real-world contexts.¹¹⁸

This chapter employed an inductive analytic approach despite the existence of well-established theories related to competency-based education and professional entrustment. Deductive approaches apply theoretical frameworks *a priori* to structure coding and interpretation, whereas inductive approaches allow patterns to emerge directly from participant data.¹¹⁸⁻¹²⁰ Had a deductive framework been applied, interpretation would have been structured differently and may have constrained attention to unanticipated implementation challenges. In this study, inductive analysis enabled insight into how EPAs functioned alongside, and sometimes in tension with, existing assessment systems in the UW PharmD curriculum.

3.3.6 Methodological Considerations

In health professions education, EPAs are typically implemented as part of an assessment system characterized by repeated observations, multiple assessors, ongoing entrustment decisions, and integration with curricular progression.^{126,127} Within such systems, EPAs are embedded over time to support judgments about increasing independence and readiness for unsupervised practice. In contrast, the implementation of EPAs in this study was deliberately limited and evaluative. EPAs were introduced as an adjunct assessment tool, used alongside existing evaluation instruments rather than replacing them. Assessments were conducted over a single experiential term, with a limited number of observations and without formal entrustment decision-making tied to progression or advancement. This constrained implementation represents a methodological limitation. Participants' perceptions of EPAs were shaped by brief exposure, concurrent, mandatory assessments, and the absence of downstream consequences that may be associated with entrustment decisions. As such, findings should be interpreted as reflections on the perceived utility and feasibility of EPAs under exploratory conditions, rather than as evaluations of EPAs functioning within a fully established, competency-based education system. By examining EPAs within an existing experiential education infrastructure, the study provides actionable insight into the challenges and opportunities associated with introducing EPAs into established assessment ecosystems.¹¹⁹

3.3.7 Conclusion

This study prioritized methodological rigor, data integration, and pragmatic relevance, while remaining theoretically informed but deliberately avoiding deductive theoretical constraint. As qualitative health research scholars emphasize, rigor in mixed-methods research arises from alignment among research questions, data sources, analytic strategies, and epistemological stance.¹¹⁸⁻¹²⁰ The pragmatic, inductive mixed-methods approach employed here reflects such alignment and supports the credibility, transferability, and applied relevance of the findings for experiential education stakeholders.

3.4 Reflexivity Statement: Chapters 5 and 6

Reflexivity involves self-questioning and self-understanding to help emphasize the importance of self-awareness, political and cultural consciousness, and ownership of one's perspective.¹¹⁸ **Chapters 5 and 6** were approached from a realist-pragmatic position, recognizing that researchers' professional roles, prior experiences, and assumptions shape all stages of inquiry.¹¹⁸ Reflexivity was therefore integrated throughout study design, data collection, analysis, and interpretation to enhance transparency and credibility.¹¹⁸ Team members possess professional and scholarly experience in pharmacy practice and education, and this positionality provided contextual insight into experiential structures and assessment practices, but also required active attention to potential interpretive bias.

To mitigate these influences, datasets were de-identified prior to analysis, inductive coding was used to privilege participant-generated meaning, and analytic decisions were made collaboratively through reflexive dialogue rather than statistical agreement.¹¹⁸⁻¹²⁰ Theory was treated as contextual scaffolding rather than an analytic constraint, consistent with Patton's view of theory-informed evaluation research.¹¹⁸ In integrating quantitative and qualitative findings, the research team remained attentive to how numerical summaries might privilege dominant perspectives or obscure minority views. Qualitative findings were therefore used to contextualize and nuance quantitative trends rather than to confirm them. Overall, reflexivity functioned as an ongoing analytic process rather than a discrete step, supporting the production of findings that are credible, contextually grounded, and meaningful.

3.5 References

The references for this section are located at the end of Chapter 7, subsection 7.11

Chapter 4

The association between academic performance and entry-to-practice milestones within a co-operative education PharmD program

This chapter is published in the journal of Pharmacy as part of the Special Issue “Advances in Experiential Learning in Pharmacy” as follows:

Syed A, Huang Y, Goh J, Moroz S, Pugsley J, Waite NM, Houle SKD. The Association between Academic Performance and Entry-to-Practice Milestones within a Co-Operative Education PharmD Program. *Pharmacy*. 2024; 12(3):90. doi: 10.3390/pharmacy1203009

References for this published section have been kept at the end of this chapter, subsection 4.7

4.1 Overview

Research on associations between student performance in pharmacy programs and entry-to-practice milestones has been limited in Canada and in programs using a co-operative (co-op) education model. Co-op exposes students to a variety of opportunities both within direct patient care roles and in non-traditional roles for pharmacists, such as policy, advocacy, insurance, research, and the pharmaceutical industry. The purpose of this research is to analyze associations between student grades and evaluations achieved in the University of Waterloo (UW) Doctor of Pharmacy (PharmD) co-op program and success rates on entry-to-practice milestones, including the Pharmacy Examining Board of Canada (PEBC) Pharmacist Qualifying Examination and performance on final-year clinical rotations. Grades and evaluations from courses, co-op work terms, clinical rotations, and PEBC exam data from three graduating cohorts were obtained. A multiple regression analysis was performed to explore associations between student evaluations and PEBC Pharmacist Qualifying Examination and clinical rotation performance. Holding all other variables constant, grades in anatomy/physiology were negatively correlated with scores on the PEBC Pharmacist Qualifying Examination, while grades in one of the professional practice courses showed a positive relationship with the same examination. Students with higher grades in a problem-based learning capstone therapeutics course, in their first co-op work term, and in the direct patient care co-op work term tended to score higher on clinical rotations. Co-op performance was not significant in predicting PEBC performance. However, complimentary descriptive analysis underscored that students with a co-op rating of good or below were more likely to fail courses, midpoint evaluations, Objective Structured Clinical Examinations (OSCEs), and PEBC measures. Multiple predictors of performance on final-year clinical rotations and the PEBC Pharmacist Qualifying Examination were identified. This predictive model may be utilized to identify students at risk of underperforming and to facilitate early intervention and remediation programs, while also informing curricular revision.

4.2 Introduction

Health professional degree programs face challenges with adequately preparing new graduates for practice in a dynamic healthcare system.^{1,2} Misalignment between competencies assessed within health professional curricula and those applied within healthcare systems may compromise the student-to-practitioner transition and contribute to new graduates' feelings of

professional inadequacy.² In Canada, the pharmacy education system has evolved in response to emerging and expanded roles for pharmacists, which require a greater focus on clinical interventions and interprofessional collaboration to optimize patient care.³

Adequately preparing pharmacy graduates for practice involves continuous curricular evaluation, with experiential placements crucial for developing discipline-specific skills.⁴ Addressing the challenge of aligning pharmacy education with the dynamic healthcare landscape may involve incorporating work-integrated learning (WIL), such as co-operative (co-op) education.⁵ Co-op integrates didactic education and practical work experience, promoting continuous learning and enhancing job readiness by identifying essential competencies for practice in response to current and future healthcare needs.^{6,7} However, with only two co-op pharmacy programs in North America, there is a research gap regarding the association between academic performance within a co-op program and subsequent performance in entry-to-practice assessments.

To optimize curriculum and identify students who would benefit from additional support, it is crucial to explore potential predictors of readiness, like student grades, milestone assessments, and experiential placements. These predictors, when correlated with established surrogates of readiness, such as certification/licensure exam pass rates, help appraise components of pharmacy education. Studies have identified predictors for performance on pharmacist licensing exams, such as pre-admission grade point average (GPA), performance on the Pharmacy College Admission Test (PCAT), and pharmacy program GPA.^{8,9,10} However, the concept of readiness for entry-to-practice lacks a consistent definition and varies across practice settings. Generally, it refers to possessing the knowledge, skills, and judgment required for a specific role.¹¹ Recognizing the evolving nature of pharmacy education and the unique characteristics of our co-op program at the University of Waterloo (UW), a focused analysis is necessary to understand the specific factors influencing readiness for entry-to-practice among our graduates.

In the United States, pharmacists must pass the North American Pharmacist Licensure Examination (NAPLEX) to obtain licensure, while in Canada, the standard exam is the Pharmacy Examining Board of Canada (PEBC) Pharmacist Qualifying Examination, which includes a Part I Multiple-Choice Question (MCQ) and a Part II Objective Structured Clinical

Examination (OSCE).^{12,13} In the United Kingdom, pharmacists take the General Pharmaceutical Council (GPhC) Registration Assessment.¹⁴ Similarly, in Australia, pharmacists must take the Australian Written Intern Examination to secure their licensure.¹⁵ Shah et al. emphasized the importance of identifying reliable predictors of NAPLEX outcomes and students at risk of poor performance.¹² This is crucial not only for ensuring the competence of future pharmacists, but also for informing educational strategies and interventions aimed at supporting students' success. Similar concerns likely exist within the Canadian context, where understanding factors influencing performance on the PEBC Pharmacist Qualifying Examination is equally essential for maintaining high standards in pharmacy practice.⁸

Program Overview

The UW PharmD program, Canada's only co-operative (co-op) undergraduate pharmacy program and one of two in North America, begins with foundational sciences and an introduction to professional practice in year one.^{16,17} In years two to four, students delve into Integrated Patient Focused Care (IPFC), a series of nine courses covering therapeutic areas by system, including pathophysiology, pharmacology, pharmacokinetics, critical appraisal, and clinical problem-solving.¹⁷ From year two, students also undergo annual OSCE exams, and a midpoint exam is completed in year two to identify at-risk students and offer remediation.¹⁷

Experiential education consists of a Community Service Learning (CSL) milestone, co-op work terms, and final-year clinical rotations:

1. CSL is a mandatory non-course degree requirement and milestone in the PharmD program.¹⁷ CSL consists of three phases, preparation, action, and application, aimed at engaging PharmD students in service activities, reflecting on personal and professional goals, and contributing to community health.¹⁷
2. The co-op program mandates three employer-paid 16-week full-time work terms, with the initial two work terms occurring in the second year and the final one in the third year.⁷ Students can experience various work settings, including primary care, institutional pharmacy, industry, government, and research.⁷ They can secure placements through competitive applications and job interviews with school-recruited positions or self-arrangement.⁷ Student responsibilities align with the employer's job description, with terms and passing requirements detailed in Table A-4.1.⁷

3. During clinical rotations, students assess patients, address drug-related needs, devise and execute care plans, and co-operate with interprofessional teams to enhance patient outcomes.¹⁸ These unpaid courses require students to complete all three rotation placements within a lottery-assigned region in Ontario.¹⁸ Course numbers correspond to the care setting, including institutional, primary care, and elective rotations.¹⁸
4. Additional information on the curriculum is provided in (Figure A-4.1) and in Appendix 4A. A complete list of abbreviations can be found in Appendix 4B.

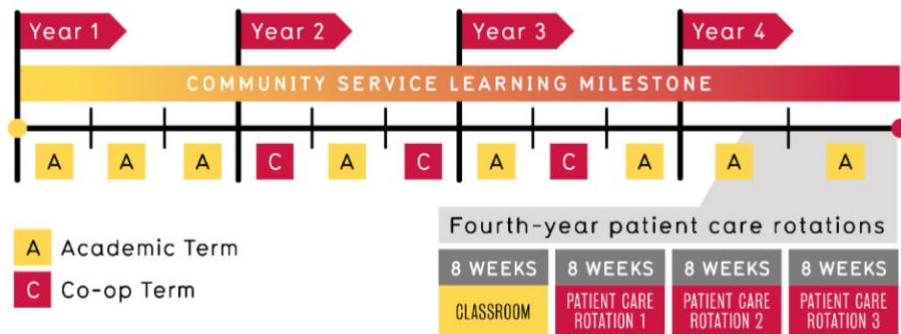


Figure A-4.1. University of Waterloo PharmD program curricular sequence.

Table A-4.1. Data utilized in multiple linear regression analyses.^{7,13,17,18}

Evaluation	Assessment(s) and Minimum Performance Required to Pass
Didactic courses *	Final grade of 60% or higher
Co-op work terms *	PharmD Inventory of Skills Evaluation (Appendix 2C): <ul style="list-style-type: none"> • Overall rating of “good” or higher for each of: <ul style="list-style-type: none"> ○ Communication (all work terms) ○ Drug distribution (work term 1 or 2) ○ Direct patient care (work term 2 or 3) • Overall rating of “meets expectations” or higher for professionalism (all work terms) Co-op Student Performance Evaluation (CSPE) (Appendix 2D): <ul style="list-style-type: none"> • Overall rating of “marginal” or higher (all work terms)
Midpoint assessment	Modified Angoff process used to set passing score (generally approximately 60%)
Annual OSCE	Modified Angoff process used to set passing score (generally approximately 60%)
Direct patient care rotations *	Overall grade of 70% or higher comprised of: <ul style="list-style-type: none"> • Patient care skills (85%) assessed using the Ontario Pharmacy Patient Care Assessment Tool (OPPCAT) at 2 weeks (formative), 4 weeks (25%), and 8 weeks (60%) • Interprofessional practice (5%), where students’ inter-professional practice is evaluated by an evaluator from a different profession in a summative manner • Community of practice assignment (10%), where students address practice gaps within the community by sharing new information with health professionals and/or providing a service to patients
PEBC Pharmacist Qualifying Examination	MCQ and OSCE scores

* To facilitate analysis, the following data modifications were made: Didactic courses: PHARM 126: Calculations course excluded as it was a credit/no credit course with extreme imbalance between credit (94%) and no credit (6%) outcomes. PharmD Inventory of Skills: Nine quantitative scores/competencies are assessed per student. Given variability in applicable competencies per work term, performance on each competency was averaged across the 3 work terms for each student. Co-op Student Performance Evaluation: Ratings were combined into the categories of good and below, very good, excellent, and outstanding, and assigned numerical scores of 1–4, respectively, due to the limited number of marginal and satisfactory ratings (n = 7) compared to the number of good, very good, excellent, and outstanding ratings.

The research to date examining relationships between pharmacy student performance in academic programs and entry-to-practice assessments is limited and does not encompass programs with unique curricular features, like co-op.^{8,9,10,19} Notably, there is growing interest in the co-op model as a robust WIL model. This paper aims to fill this knowledge gap by investigating whether course grades and evaluations, including co-op work terms and direct patient care rotation courses, correlate with performance on entry-to-practice measures in a Canadian co-op pharmacy program.

4.3 Materials and Methods

Two predictive validity studies were conducted using a retrospective multiple-cohort design: the first explored the relationship between didactic and experiential scores and performance on the

PEBC Pharmacist Qualifying Examination Parts I and II ((MCQ and OSCE), while the second explored the relationship between didactic and experiential scores and performance on clinical rotations. Ethics approval for this study was received from the Research Ethics Board at the University of Waterloo (ORE# 43127).

4.3.1 Data Collection

Academic performance data were obtained from the Office of the Registrar and School of Pharmacy for all students (n = 343) that graduated from the UW PharmD program between 2017 and 2019 to capture data within a consistent curricular window. Specifically, the UW entry-to-practice PharmD degree was first offered to the graduating class of 2015, representing a transition from a previous Bachelor of Science in Pharmacy degree. Data from the 2015 and 2016 cohorts were excluded since modifications were being made to the PharmD curriculum before reaching a consistent structure for the 2017 graduating cohort. Data from the graduating classes of 2020 onwards were also excluded due to the impact of the COVID-19 pandemic on the PharmD curriculum. Data utilized including assessment(s) and minimum requirements are outlined in Table A-4.1.^{7,17,18} CSL data were not analyzed as it is a non-course, credit/no-credit milestone, focusing on experiences that would vary significantly between students, which would be challenging to standardize for incorporation into a regression model. Performances on the MCQ and OSCE components of the PEBC Qualifying Examination were provided by PEBC under a blinded, anonymized, data-sharing agreement.

Students' identifiable information (e.g., name and student number) was de-identified by a co-investigator data steward to maintain anonymity before being released to the rest of the research team for analysis.

4.3.2 Data Exploration

Correlation coefficients among numerical predictor variables were explored prior to the development of a regression model to avoid a compromised interpretation of the regression. In general, highly correlated predictor variables can be explained by similarities between course type, theme, and/or structure. Term average scores as one of the predictor variables were found to be highly correlated with one or more courses and were excluded from the regression model.

High-correlation coefficients (denoted by r) among the remaining predictor variables are listed in Appendix 4E, in which correlations greater than 0.7 were considered highly correlated.

4.3.3 Data Analyses

Two analyses were separately performed using multiple linear regressions with backward stepwise selection. Backward selection starts the regression models with all predictor variables and drops a predictor variable from the regression model one at a time until regression models reach their best Akaike information criterion (AIC) performance.²⁰ The backward selection approach assisted in the selection of relevant predictor variables with the goal of developing a parsimonious and efficient model. To prevent any variables of particular interest from being eliminated by backward selection, the research team identified critical courses/inputs and ensured their inclusion in the model. The following were selected based on a consideration of those that had demonstrated statistically significant correlations with certain entry-to-practice milestones in the published literature, and those that are compulsory components of the curriculum with direct applicability to the provision of patient care:^{8,9,10,12,13,17,18,19,21,22,23,24,25,26,27}

- Integrated Patient-Focused Care series courses: PHARM 220, 221, 222, 223, 320, 321, 323, 324, and 422;
- Professional Practice series courses: PHARM 129, 130, 228, 229, 329, and 330;
- Pharmacokinetics: PHARM 224;
- Co-op work-term scores;
- PharmD rotation scores;
- Midpoint assessment MCQ scores;
- Year 1, 2, 3, and 4 OSCE scores.

4.3.3.1 Analysis 1—The Relationship between Student Course and Experiential Education Performance with PEBC Pharmacist Qualifying Examination Performance (Part I MCQ and Part II OSCE)

Four multiple linear regressions were performed. As there is a high degree of similarity between OPPCAT scores and the overall rotation course scores (i.e., OPPCAT accounts for 85% of the associated rotation course score), we used OPPCAT and rotation course scores as predictor variables separately in the analysis to avoid issues with multicollinearity. Except for the

OPPCAT or the rotation course, all four regressions included the same didactic scores and co-op work-term scores for the backward selection, with the following variations related to rotation performance and dependent variables:

- Variation 1: OPPCAT only as predictor variable for rotation performance with PEBC Pharmacist Qualifying Examination Part I (MCQ) as the dependent variable;
- Variation 2: OPPCAT only as predictor variable for rotation performance with PEBC Pharmacist Qualifying Examination Part II (OSCE) as the dependent variable;
- Variation 3: Rotation course overall as predictor variable for rotation performance with PEBC Pharmacist Qualifying Examination Part I (MCQ) as the dependent variable;
- Variation 4: Rotation course overall as predictor variable for rotation performance with PEBC Pharmacist Qualifying Examination Part II (OSCE) as the dependent variable.

4.3.3.2 Analysis 2—The Relationship between Didactic Courses and Co-Op Performance with Rotation Performance

Six multiple linear regressions were performed. All six regressions included the same didactic scores and co-op work-term scores as predictor variables for the backward selection, with variations in dependent variables related to rotations performance consistent with the approach taken previously:

- Regression 1: OPPCAT only from the first completed rotation as the dependent variable;
- Regression 2: OPPCAT only from the second completed rotation as the dependent variable;
- Regression 3: OPPCAT only from the third completed rotation as the dependent variable;
- Regression 4: PHARM 430 (Primary Care) rotation overall score as the dependent variable;
- Regression 5: PHARM 440 (Institutional) rotation overall score as the dependent variable;
- Regression 6: PHARM 450 (Elective) rotation overall score as the dependent variable.

4.3.3.3 Model Diagnostics

All relevant model diagnoses (i.e., normal QQ plot and residual diagnostic plot) were conducted to examine the model fit, which found that no obvious linear model assumptions were

violated across all analyses. The variance inflation factor was also computed for each analysis, which suggests that the statistical models do not have multicollinearity issues.

4.3.3.4 Complimentary Descriptive Analysis

We compared the rates of course failure and near failure (defined as 60–70% for didactic courses, 60–65% for annual OSCE, and 70–75% for rotations courses) between students that received a marginal, satisfactory, and/or good score across at least one co-op work term and those scoring very good and above across all work terms.

4.4 Results

In this section, we will present the results obtained from the regression models. Both Table B-4.2 and Table C-4.3 only show the variables selected by the backward selection with a 0.05 significance level. Coefficients are estimated with the maximum likelihood estimation method and describe the relationship between the predictor and dependent variables.

Table B-4.2. Statistically significant relationships for analysis 1.

Course	Estimated Coefficient β	<i>p</i> -Value
OPPCAT only as predictor variable for rotation performance with PEBC MCQ as dependent variable		
PHARM 111: Anatomy and Physiology 2	-3.46	<i>p</i> = 0.001
PHARM 229: Professional Practice 4	3.87	<i>p</i> = 0.03
PHARM 321: Integrated Patient-Focused Care 6	-3.17	<i>p</i> = 0.03
PHARM 324: Integrated Patient-Focused Care 8	3.95	<i>p</i> = 0.002
PHARM 330: Professional Practice 6	-2.89	<i>p</i> = 0.04
Year 4 OSCE score	1.55	<i>p</i> = 0.03
Midpoint MCQ score	2.50	<i>p</i> < 0.001
Rotation 3 OPPCAT score	1.74	<i>p</i> = 0.04
OPPCAT only as predictor variable for rotation performance with PEBC OSCE as dependent variable		
PHARM 111: Anatomy and Physiology 2	-2.98	<i>p</i> = 0.01
PHARM 228: Professional Practice 3	2.40	<i>p</i> = 0.04
PHARM 229: Professional Practice 4	3.72	<i>p</i> = 0.04
PHARM 350: Fundamentals of Business Administration and Management	-2.39	<i>p</i> = 0.05
PHARM 425: Symposium	1.93	<i>p</i> = 0.03
Rotation course overall as predictor variable for rotation performance with PEBC MCQ as dependent variable		
PHARM 111: Anatomy and Physiology 2	-3.43	<i>p</i> = 0.002
PHARM 229: Professional Practice 4	3.65	<i>p</i> = 0.04
PHARM 321: Integrated Patient-Focused Care 6	-3.15	<i>p</i> = 0.03
PHARM 324: Integrated Patient-Focused Care 8	3.97	<i>p</i> = 0.003
PHARM 330: Professional Practice 6	-2.70	<i>p</i> = 0.05
Year 4 OSCE score	1.54	<i>p</i> = 0.03

Midpoint MCQ score	2.52	$p < 0.001$
Rotation course overall as predictor variable for rotation performance with PEBC OSCE as dependent variable		
PHARM 111: Anatomy and Physiology 2	-2.98	$p = 0.01$
PHARM 228: Professional Practice 3	2.56	$p = 0.03$
PHARM 229: Professional Practice 4	3.69	$p = 0.05$
PHARM 350: Fundamentals of Business Administration and Management	-2.57	$p = 0.04$
PHARM 425: Symposium	1.93	$p = 0.03$

Table C-4.3. Statistically significant relationships for analysis 2.

Course	Estimated Coefficient β	p -Value
OPPCAT only from first completed rotation as dependent variable		
PHARM 222: Integrated Patient-Focused Care 3	-0.29	$p = 0.02$
PHARM 232: Medical Microbiology	-0.20	$p = 0.02$
PHARM 422: Integrated Patient-Focused Care 9	0.32	$p < 0.001$
OPPCAT only from second completed rotation as dependent variable		
Graduation year 2017	3.21	$p = 0.04$
PHARM 124: Pharmaceutics 1	0.26	$p = 0.01$
PHARM 220: Integrated Patient-Focused Care 1	0.28	$p = 0.02$
PHARM 222: Integrated Patient-Focused Care 3	-0.24	$p = 0.03$
PHARM 227: Health Systems in Society	-0.23	$p < 0.001$
PHARM 228: Professional Practice 3	0.33	$p < 0.001$
OPPCAT only from third completed rotation as dependent variable		
PHARM 129: Professional Practice 1	-0.20	$p = 0.04$
PHARM 222: Integrated Patient-Focused Care 3	-0.40	$p < 0.001$
PHARM 350: Fundamentals of Business Administration & Management	0.24	$p = 0.03$
PHARM 422: Integrated Patient-Focused Care 9	0.28	$p < 0.001$
CSPE overall (work term 1)	0.84	$p = 0.03$
Co-op direct patient care scores	1.95	$p = 0.04$
PHARM 430 (Primary Care) rotation overall score as dependent variable		
Graduation year 2018	-2.44	$p = 0.03$
PHARM 155: Drug Information Fundamentals	-0.19	$p = 0.02$
PHARM 321: Integrated Patient-Focused Care 6	0.27	$p = 0.03$
PHARM 422: Integrated Patient-Focused Care 9	0.22	$p < 0.001$
PHARM 440 (Primary Care) rotation overall score as dependent variable		
Graduation year 2017	2.23	$p = 0.03$
PHARM 124: Pharmaceutics 1	0.22	$p = 0.01$
PHARM 125: Pharmaceutics 2	-0.18	$p = 0.04$
PHARM 228: Professional Practice 3	0.17	$p = 0.04$
PHARM 232: Medical Microbiology	-0.17	$p = 0.01$
PHARM 422: Integrated Patient-Focused Care 9	0.17	$p = 0.01$
PHARM 450 (Elective) rotation overall score as dependent variable		
PHARM 129: Professional Practice 1	-0.21	$p = 0.01$
PHARM 222: Integrated Patient-Focused Care 3	-0.38	$p < 0.001$
PHARM 228: Professional Practice 3	0.22	$p = 0.01$
PHARM 252: Institutional Pharmacy Practice	0.16	$p = 0.04$
PHARM 320: Integrated Patient-Focused Care 5	0.26	$p = 0.01$
PHARM 422: Integrated Patient-Focused Care 9	0.22	$p < 0.001$
PHARM 425: Symposium	0.15	$p = 0.02$
Year 1 OSCE score	-0.10	$p = 0.04$

CSPE overall (work term 1)	0.66	$p = 0.04$
Co-op direct patient care scores	2.07	$p = 0.01$

4.4.1. Analysis 1—The Relationship between Student Course and Experiential Education Performance with PEBC Exam Performance (MCQ and OSCE)

Excluding the missing data, analysis 1 includes 301 students, with 50 candidate predictor variables and two response variables (PEBC MCQ and OSCE scores). Only those variables selected by backward selection with significant coefficients in the regression models are reported in Table B-4.2.

4.4.2 Analysis 2—The Relationship between Didactic Courses and Co-Op Performance with Rotation Performance

Excluding the missing data, analysis 2 includes 308 students with 47 candidate predictor variables and three response variables (OPPCAT 1, 2, and 3 scores). Only those variables selected by backward selection with significant coefficients in the regression models are reported in Table C-4.3.

4.4.3 Complimentary Descriptive Analysis

Of the 343 students included in this analysis, 85% received overall CSPE ratings above the good level (i.e., very good, excellent, and/or outstanding) across all three co-op work terms, seven students (2%) received at least one overall CSPE rating below the good level (i.e., marginal and/or satisfactory), and 44 students (13%) received at least one overall CSPE rating of good. Inferential analysis will not produce meaningful results due to the highly imbalanced grade distribution. As seen in the summarized findings in Table D-4.4, each cell refers to a subgroup of students. Given the small subgroup of students, there is an overlap between students in each category.

Table D-4.4. Course, OSCE, midpoint exam, OPPCAT and PEBC failures, and near failures by co-op performance

	Overall co-op rating below good across one or more work terms (n=7)	Overall co-op rating of good across one or more work terms (n=44)	Overall co-op rating of good or above across all work terms (n=336)	Overall co-op rating of very good or above across all work terms (n=292)
Performance in PharmD Program (n, %)				
Failure of at least one course	1 (14%)	4 (9%)	14 (4%)	11 (4%)
Near failure of at least one course	5 (71%)	31 (71%)	183 (55%)	157 (54%)
Failure of at least one annual OSCE	5 (71%)	30 (68%)	165 (49%)	140 (48%)
Near failure of at least one annual OSCE	5 (71%)	34 (77%)	248 (74%)	219 (75%)
Failure of midpoint assessment	2 (29%)	7 (16%)	46 (14%)	41 (14%)
Near failure of midpoint assessment	3 (43%)	25 (57%)	117 (35%)	95 (33%)
Failure of at least one OPPCAT	0 (0%)	0 (0%)	5 (2%)	5 (2%)
Near failure of at least one OPPCAT	4 (57%)	10 (23%)	31 (9%)	25 (9%)
Performance on PEBC Pharmacist Qualifying Examination (n, %)				
Failure of Part I (MCQ)	3 (43%)	6 (14%)*	24 (7%) [±]	21 (7%) ^Δ
Failure of Part II (OSCE)	1 (14%)	6 (14%)*	11 (3%) [±]	6 (2%) ^Δ

* n = 43 due to missing data; ± n = 327 due to missing data; Δ n = 284 due to missing data.

4.5 Discussion

This is the first study to assess performance on the Canadian PEBC Pharmacist Qualifying Examination and final-year clinical rotations within a pharmacy program using a co-operative education model. Positive and negative coefficients were identified from linear models based on pharmacy school performance as well as PEBC-Part I (MCQ) and Part II (OSCE) outcomes. Notably, co-op experiences showed no significant association with PEBC Pharmacist Qualifying Examination outcomes. Furthermore, the conversion of PharmD rotation OPPCAT scores to overall PharmD rotation grades yielded comparable coefficients with the PEBC Pharmacist Qualifying Examination, emphasizing the predictive value of overall rotation course performance. Descriptive statistics revealed a relationship between subpar co-op performance and multiple program milestones, underscoring the importance of CSPE ratings as predictive indicators for program success.

This study employs multiple linear regression analysis to identify predictors of performance, providing a comprehensive assessment of practice readiness. Our study identifies key predictors of PharmD rotation and PEBC performance during a consistent curricular window, offering an opportunity for early intervention with at-risk students. As the PEBC Pharmacist Qualifying Examination is nationally administered, this model may be replicated by

other Canadian schools of pharmacy to identify their own predictors of success on practice readiness milestones.¹³ This model uniquely includes co-op performance variables as well as both formative and summative measures, enhancing its utility and relevance. This model is also the first to include a midpoint evaluation, as other studies have only explored the Pharmacy Curriculum Outcomes Assessment (PCOA), which is analogous to a midpoint assessment across pharmacy schools in the United States.^{24,26} Additionally, it suggests potential curriculum revisions to optimize student success, such as re-evaluating course weight, structure, and assessments based on identified associations, particularly courses with inverse relationships to performance in clinical rotations and the PEBC Pharmacist Qualifying Examination.²⁷

We identified several positive regression coefficients between pharmacy school performance and PEBC QE Part I (MCQ) outcomes. Noteworthy associations included scores in professional practice (PP) 4, IPFC 8, year 4 OSCE, midpoint MCQ, and clinical rotation 3 OPPCAT. Courses such as PP 4, following a hybrid model of didactic lecturing and laboratory time involving practice-based assessments, and IPFC 8, involving didactic lecturing in a large classroom environment alongside frequent, rigorous assessments, demonstrated positive associations with PEBC QE I (MCQ) outcomes. These findings suggest that courses taken later in the program, focusing on pharmacy practice and therapeutic content, as well as the assessment of patient care competencies, may contribute to the observed coefficients.

Negative coefficients between performance in pharmacy-school and PEBC QE I (MCQ) outcomes were also identified. Notable negatively correlated variables included scores in Anatomy and Physiology 2 and PP 6. Anatomy and Physiology 2 is a didactic, instructor-led course alongside a wet lab, prior to any patient care experiences, and success in this course is largely dependent on rote memorization. Like PP4, PP6 follows a hybrid model of didactic lecturing and laboratory time, while addressing additional topics, such as job acquisition, negotiations, drug shortages, ethics, and professionalism, expanded scope, and documentation strategies. These discrepancies in content relevance and assessment methodologies may explain the observed negative coefficients.

Similarly, positive coefficients were found between pharmacy-school performance and PEBC QEII (OSCE) outcomes, particularly with courses such as PP 3, PP 4, and the symposium (where students present seminars and demonstrate their skills in evaluating literature and

synthesizing information in written and oral formats) emphasizing pharmacy practice experiences, patient care, communication, and engagement. Conversely, courses such as Anatomy and Physiology 2 and Fundamentals of Business Administration and Management exhibited negative associations with PEBC OSCE outcomes, possibly due to the stark differences in content relevance and competency assessment structures offered in these courses versus a practical clinical assessment.

Both parts of the PEBC Qualifying Examination were positively related with PP 4 scores and negatively correlated with Anatomy and Physiology 2. Interestingly, no association was observed with co-op evaluations, suggesting divergent competencies assessed by co-op, (e.g., job performance, interest in work, quality of work, teamwork, resourcefulness, entrepreneurial orientation, response to supervision, etc.) and the PEBC Qualifying Examination, which focuses on entry-to-practice competencies of pharmacists.

Positive relationships between performance in pharmacy-school and final-year PharmD clinical rotation OPPCAT outcomes were identified, notably with scores in IPFC 9 and co-op direct patient care. This may be since IPFC 9 is the final therapeutics course in the program and applies a problem-based learning approach in a self-directed format, which may draw similarities with clinical practice. The positive coefficients between co-op direct patient care scores and rotation OPPCAT 3 scores may result from similar competencies assessed in both, with OPPCAT 3 reflecting improved clinical performance as the final PharmD rotation. Conversely, negative relationships were found with scores in IPFC 3. Despite structural similarities across most IPFC courses, the reasons for this negative relationship are uncertain and may involve factors such as course content or teaching and assessment styles, which will be examined in future work.

Descriptive statistics reveal a relationship between subpar co-op performance and multiple milestones in the UW PharmD curriculum. Students with below-good CSPE ratings were 3.5-times more likely to fail courses and 1.3-times more likely to experience near failures compared to those with good or above ratings. Additionally, they showed higher probabilities of failing the OPPCAT (6.3-fold), PEBC Part I (MCQ) (6-fold), PEBC Part II (OSCE) (4.7-fold), midpoint (2-fold), and annual OSCE (1.4-fold). Similarly, students with “good” CSPE ratings were more likely to experience failures or near failures across various measures, suggesting an association between CSPE ratings and program success. These findings underscore the

importance of early identification and intervention for students exhibiting lower CSPE ratings, potentially indicating a need for targeted support mechanisms to improve overall program outcomes. Furthermore, the consistently higher probabilities of failure across multiple assessments for students with below-good CSPE ratings highlight the significance of addressing underlying issues in co-op performance as a potential predictor of broader academic challenges.

Our study supports the findings of previous studies exploring predictors of performance in pharmacy school and on pharmacist licensing exams, while introducing additional predictors.^{10,12,24,25,26} In a study by Call et al., students who received a failing grade on one or more advanced pharmacy practice experiences (APPEs) were compared to other students that passed; however, this was performed using a retrospective approach specific to one cohort and did not involve the use of a predictive model.¹⁹ In close alignment with our study, Shah et al. and Cor et al. developed a predictive model to identify students at risk of poor performance on the NAPLEX and isolated pre-admission and pharmacy program predictors.^{12,21} Shah et al. found their predictive model to be a practical tool in which four of the five predictors could be generalizable to other schools of pharmacy.¹² Similarly, Cor et al. found that biology-based prerequisites had a consistent relationship with academic performance, suggesting a need for reconsideration of admissions GPA criteria and the inclusion of non-traditional predictors to better assess student success.²¹

Studies by McCall et al., Chisholm-Burns et al., Allen et al., Garavalia et al., and Elder et al. also identified significant pharmacy program predictors of NAPLEX performance.^{10,22,23,24,25} McCall et al. identified the composite PCAT score as the primary predictor for NAPLEX outcomes, yet the combined predictive power of PCAT, Critical Thinking Skills Test scores, prepharmacy GPA, and age was relatively low, emphasizing the need for a comprehensive review of each candidate's application.²² Chisholm-Burns et al. stressed the critical role of first-year pharmacy GPA in predicting on-time graduation and NAPLEX success, underscoring the importance for close monitoring of student performance in the initial year and proactive support for those facing academic challenges.¹⁰ Allen et al. identified no unsatisfactory grades in the prepharmacy program and a high cumulative GPA in the PharmD program as significant predictors of success on the NAPLEX, emphasizing the importance of academic performance throughout the program.²³ Garavalia et al. emphasized the correlation between GPA, PCOA

scores, and NAPLEX performance, stressing the importance of validating PCOA scores for academic decision making.²⁴ Elder et al. found that performance on specific pharmacy clinical skills lab assessments predicted total NAPLEX scores, indicating the need for early intervention for struggling students.²⁵ However, these studies focus on the NAPLEX, which differs in structure and competencies compared to the PEBC. Furthermore, these studies analyzed one measure of practice readiness, as opposed to examining multiple measures of practice readiness and teasing out mutual predictors between them.

A Canadian study conducted by Cameron and colleagues explored predictors of performance on the PEBC Qualifying Examination among pharmacy students at the University of Toronto.⁸ This study found that the Multiple Mini Interview (MMI), measuring non-academic attributes, was the sole admissions tool with significant predictive validity for performance in the PEBC-OSCE and institutional/ambulatory rotation, emphasizing its importance in health professions student selection.⁸ However, this program does not offer co-op work terms and therefore may not be generalizable to our program.

The findings offer valuable insights for pharmacy education institutions, providing a foundation for early intervention strategies to support students at risk of underperforming. Additionally, the predictive model developed in this study could benefit other Canadian schools of pharmacy in identifying predictors of success on practice readiness milestones.

Future research could explore additional factors impacting pharmacy licensure exam and clinical rotation performance, such as personality profiles and resilience. While this study uses the PEBC exam and PharmD rotations as proxies for practice readiness, further research should consider other factors, such as cognitive, clinical, and professional capabilities, as well as self-efficacy that may influence both academic performance and practice readiness. Without a widely accepted definition for practice readiness, employer and preceptor perspectives on student preparedness should also be explored. Finally, future research could adopt an extended longitudinal approach that follows students through their initial years of practice to understand their transition from student to new graduate to more established healthcare professional.

4.5.1 Limitations

This study does not establish a direct cause-and-effect relationship with the identified predictors. It is important to note that our data collection was limited to student academic performance and cohort year; therefore, we are unable to comment on other individual characteristics, such as age, sex, gender, completion of another degree before entering pharmacy school, and GPA upon admission. This study was a single-institution study with a unique co-op program. In addition, more recent cohorts were affected by the COVID-19 pandemic, which may limit generalizability toward future cohorts. As PharmD students may not satisfy the communication, distribution, and direct patient care requirements of the co-op program in a fixed order and may satisfy them more than once on a given co-op term, it was necessary to average these scores across the three terms. Averaging may underrepresent the information contained in the co-op data. Finally, it is important to note that the PEBC Pharmacist Qualifying Examination is an assessment of minimal competency; therefore, assessing additional measures of practice readiness that go beyond minimal competency or that cannot be assessed by the examination format is encouraged for future studies.

4.6 Conclusions

Multiple significant predictors of performance on PharmD clinical rotations and the PEBC exam were identified. Subpar performance on co-op correlated with poor performance on a number of curricular milestones. These curricular performance predictors can be used to identify students at risk of underperforming, to facilitate early intervention and remediation programs, as well as inform curricular revision. Future studies should evaluate and propose a standardized definition for practice readiness for pharmacists and explore qualitative perspectives of employers and preceptors on student and new graduate preparedness for practice. Educators are encouraged to pay particular attention to students' performance in professional practice and therapeutics courses, as a poor performance in these may indicate a need for additional support to ensure success in final-year rotations and licensure exams.

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Chapter 5

Fostering career-readiness in pharmacy students through work-integrated learning: Qualitative analysis of co-op supervisor and rotation preceptor feedback on student performance

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References for this published section have been kept at the end of this chapter, subsection 5.7

5.1 Overview

Introduction

Work-integrated learning (WIL) is a key component of many professional programs, allowing students to apply classroom knowledge in workplace and practice settings. While most pharmacy schools include clinical rotations in their curriculum, few integrate co-operative education (“co-op”), resulting in a dearth of literature regarding how each WIL model prepares students for pharmacy careers. We analyzed student performance evaluations to identify co-op supervisors' and rotation preceptors' perceptions of students' job/practice readiness skills, distinguishing the unique and complementary skills developed by each experience.

Methods

In the University of Waterloo Doctor of Pharmacy (PharmD) program, students complete three co-op work terms in their second and third years and three clinical rotations in their fourth year. Supervisor and preceptor qualitative feedback on student performance for students in three graduating classes was qualitatively analyzed; two researchers independently coded data, using content analysis to identify themes.

Results

Both WIL models support students' growth in confidence, ability to engage in tailored communication with patients, and improved collaboration with other healthcare providers. A hierarchy of learning was observed with co-op helping students gain experience as a contributing member of an interprofessional team and learning how to adapt to workflow changes. This provided a foundation for final-year rotations allowing students to focus and gain self-assurance providing patient care services.

Discussion

Supervisors and preceptors perceive that co-op and rotations provide students with multiple important skills for job/practice readiness. Co-op's fostering of job readiness skills prepares students for more advanced, focused, and nuanced practice skill development in the program's final year.

5.2 Introduction

Work-integrated learning (WIL) is a form of experiential education that allows students to apply their academic knowledge in workplace and practice settings.¹ For pharmacy programs, rotations are a well-established type of WIL and a key curricular component during which students complete unpaid placements in various settings to gain hands-on experience in pharmacy practice.² In many North American pharmacy schools, rotations that occur early in the program are termed Introductory Pharmacy Practice Experiences (IPPEs) and consist of placements with a restricted amount of hours during which students are first exposed, within the academic program, to the transition from classroom to practice. The objectives of IPPEs have progressed beyond a basic job-shadowing experience and aim to have students build foundational skills through completing specific duties under direct supervision, to prepare students to be both practice-ready and intra- and inter-professional team-ready.^{3,4} IPPEs serve as preparation for final-year rotations, or Advanced Pharmacy Practice Experiences (APPEs), which are often longer in duration than IPPEs and offer enhanced opportunities for students to develop independent judgement by providing advanced clinical pharmacy services under the supervision of a preceptor.⁵ Co-operative education (or “co-op”) is a unique WIL model in pharmacy programs, alternating traditional classroom learning with paid field experience in the student’s choice of diverse settings including patient care environments as well as health policy, research, academia, and corporate workplaces. The goal of co-op is to provide students with valuable and practical work experience that will prepare them for entering the workforce as productive and competent pharmacists equipped to meet current and future healthcare needs.^{6,7}

There is no global standard to define or assess practice readiness in a pharmacy graduate, with countries and programs varying in both their curricula (including their WIL offerings) and their assessment methods.⁸ In Canada, two authorities have developed complementary pharmacy professional competencies: the Association of Faculties of Pharmacy of Canada (AFPC), which publishes competencies to be achieved upon PharmD degree completion,⁹ and the National Association of Pharmacy Regulatory Authorities (NAPRA), which publishes entry-to-practice competencies for pharmacists.¹⁰ To ensure that graduates of accredited pharmacy programs are prepared for careers in pharmacy, the Canadian Council for Accreditation of Pharmacy Programs (CCAPP) requires Canadian pharmacy schools to use the most recent NAPRA and AFPC

competencies to inform their curriculum, educational outcomes, and assessments.¹¹ CCAPP's standards include a requirement for students to complete a minimum of 40 weeks in total of practice experiences during their program to enhance their practical skills and knowledge in various pharmacy settings. This comprises 8 weeks in direct patient care early and mid-program and 32 weeks (of which 24 weeks is full-time direct patient care) towards the end of the program. Co-op work-terms are accepted as one form of practice experience. In addition, all Canadian co-op programs must meet criteria and be accredited by Co-operative Education and Work-Integrated Learning Canada.¹²

The School of Pharmacy at the University of Waterloo (UW), located in Ontario, Canada, is one of two pharmacy schools in North America with a co-op requirement. This four-year Doctor of Pharmacy (PharmD) program has an enrollment size of approximately 120 students per year, with students completing three paid 16-week co-op work terms beginning in the second year of the program that alternate with in-class academic terms, as well as three unpaid rotations in the fourth year of the program (Figure B-5.1).¹³

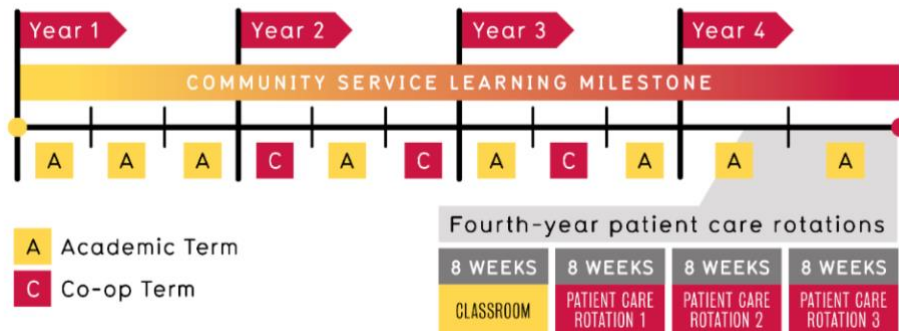


Figure B-5.1. University of Waterloo pharmacy program overview

The figure displays the structure of UW's PharmD program including work-integrated learning experiences.

There are important differences between co-op work terms and rotations for multiple variables including selection process, site types, geographical location, and compensation, as described in Table E-5.1.

Table E-5.1. University of Waterloo PharmD program WIL models.

Characteristic	Co-op Work Terms (years 2-3)	Patient Care Rotations (year 4)
Number and duration	3 at 16 weeks each	3 at 8 weeks each
Selection process	Competitive applications with job interviews with school-recruited positions, or can be self-arranged by students	Random assignment
Type of sites	Primary care (e.g., community pharmacy, family health team, outpatient clinic), institutional pharmacy (e.g., hospital or long-term care facilities) as well as other settings such as technology companies, insurance company offices, corporate head offices, government, and research or academic organizations ¹⁴	One institutional setting, one primary care setting, and a third rotation being either an institutional or primary care placement ¹⁵
Skills gained	Responsibilities are aligned with each employer's job description and vary considerably	Patient care skills (i.e., collecting medication histories, assessing drug-related needs, developing and implementing care plans, and collaborating with interprofessional colleagues)
Geographical location	Anywhere (including international sites)	Assigned region within Ontario by a matching lottery where student completes all of their rotations
Individual overseeing the student's performance	Supervisor (often a pharmacist)	Preceptor (almost always a pharmacist)
Rubric used for assessment	Inventory of Skills Evaluation (Appendix 4C) assesses four key competencies: communication, professionalism, medication distribution, and direct patient care. Students must meet distribution and direct patient care competencies during at least one of their three co-op work terms. Co-op Performance Evaluation (Appendix 4D) assesses 16 attributes and skills that are indicative of how well the student conducts themselves and performs the duties assigned at their co-op setting.	Ontario Pharmacy Patient Care Assessment Tool (OPPCAT) is a provincial rating system of five core pharmacist skills and competencies that pharmacy students must demonstrate to show readiness to practice: patient care, communication and education, professionalism, professional collaboration, and practice management (Appendix 5A)
Compensation to students	Yes (paid)	No (unpaid)

At the end of each co-op work term and rotation, supervisors and preceptors are required to complete student evaluations (rubrics described in Table E-5.1) to provides scores on a

number of key pharmacy competencies. Since rotations are a very common WIL model used in pharmacy programs, there is much previous research on the patient care skills they impart to students.¹⁶⁻¹⁸ With only two programs in North America using a co-op model, there is significantly less literature regarding the skills this experience develops, both uniquely and in conjunction with rotations. Prior research has demonstrated that UW PharmD students score highly on their co-op and rotation evaluations,¹⁹ providing evidence that these WIL models successfully allow students to meet the competency standards that they were designed to cultivate. In addition to quantitative scoring, they are asked to provide qualitative feedback in the form of written comments to offer greater detail on the student's performance. These comments extend beyond assessment of the pharmacy competencies evaluated by the rubrics, and are focused on areas of the students' skills and performance that they feel are particularly notable in indicating job/practice readiness.

However, to our knowledge, a deeper exploration of co-op supervisor and rotation preceptor qualitative feedback has not previously been conducted to provide a richer understanding of the specific job/practice readiness abilities and strengths that students gain during these WIL experiences. Understanding the distinct competencies that each WIL experience provides to pharmacy students to prepare them for their careers is valuable to pharmacy schools that are evaluating their current experiential training model and assessment tools or considering the merits of adding a co-op component to their existing curriculum. We examined qualitative feedback from co-op supervisors and rotation preceptors on UW PharmD student performance to explore i) their perceptions of the students' job/practice readiness skills, and ii) the distinct and complementary skills that co-op and rotations offer, as demonstrated during their WIL experiences.

5.3 Methods

5.3.1-Study design

Qualitative analysis of student performance feedback provided by rotation preceptors and co-op employers was conducted.

5.3.2-Data collection, study period, and sample size

Retrospective qualitative data from the Inventory of Skills Evaluation, the Co-op Performance Evaluation and the OPPCAT of students in the 2017, 2018, and 2019 graduating cohorts were collected, with approximately 120 students per cohort. The chosen timeframe allowed us to capture data within a consistent curricular window and excluded the pandemic period.

5.3.3-Analysis

For this secondary analysis, de-identification of the dataset was performed by individuals not involved in the analysis so that all identifiers including name, student number, and pronouns were removed before the file was shared with the rest of the research team.

Qualitative feedback was analyzed using content analysis, with a focus on the job/practice readiness skills developed or strengthened by co-op work terms and rotations, as well as the distinct and complementary skills these experiences build asynchronously. Data were coded by two members of the research team (AS [male pharmacist and researcher] and JP [female healthcare researcher]) who first independently coded a randomly selected common sample of 10% of comments, then developed a coding dictionary (based on inductive coding) that was used for the remaining 90%, with each coder independently coding half of the comments. The two researchers consulted with each other throughout the process, and modified the dictionary when necessary to add or revise codes and sub-codes. From the relationships between codes, they noted themes and sub-themes that emerged from the data. When comparing codes and discussing themes, the two researchers engaged in discourse until all disagreements and discrepancies were resolved and consensus was reached. Analysis was conducted in Microsoft Excel 2021 version 2308 (Microsoft Corporation).

5.3.4-Research Ethics

Approval was obtained from the University of Waterloo Research Ethics Board (ORE #45507).

5.4 Results

Over the study period, comments related to student job/practice readiness were analyzed for the co-op work terms of 355 students and the rotations of 345 students. Approximately 91.3% and 91.1% of students' co-op work terms and rotations, respectively, included some qualitative feedback. In total, 12,746 comments on student performance were analyzed, comprising 4,672 comments related to co-op work-terms (36.7%) and 8,074 comments regarding rotations (63.3%).

Qualitative feedback was categorized into four themes: (1) *Professionalism* (for example, applying regulations and ethical principles in practice, demonstrating an awareness of one's own practice limitations, and exhibiting professional behavior in interactions with others), (2) *Communication with other healthcare providers*, (3) *Patient care*, and (4) *Additional observations* (nuances and observations that were noteworthy but did not align with the preceding categories). We then stratified each theme into sub-themes generated from the data. Aligned with our first study objective, job/practice readiness skills observed by the co-op supervisors and rotation preceptors are displayed in Table F-5.2. Data were also organized into those skills that were unique to co-op work terms or rotations, and which were developed during co-op work terms and further strengthened and evolved during rotations, in fulfilment of our second objective. Each skill is further defined below, with supporting quotes found in Appendix 5B

Professionalism

Focused on self-improvement and demonstrated a keen willingness to learn (co-op and rotations): Students' receptiveness to feedback was noted by co-op supervisors, who indicated that students calmly took accountability for errors, learned from mistakes, and retained new learnings to apply to the next patient. Their passion for being a better pharmacist resulted in the student taking initiative to do self-directed learning during the rotations, take on more responsibility, and ask questions. For a small number of students, co-op supervisors encouraged a sharper focus on gaining knowledge on therapeutics by learning about new medications and their use, and adopting an evidence-based approach to the application of therapeutic knowledge through critical evaluation of literature. As pharmacists are expected to solve problems

independently where possible, when students encounter a new and unfamiliar issue, their first instinct should be to conduct independent research utilizing all available resources to inform their decisions.

Table F-5.2. Job/practice readiness skills observed based on thematic analysis of feedback provided by co-op supervisors and rotation preceptors

Theme	Co-op (2 nd and 3 rd year)	Rotations (4 th year)
Professionalism	<ul style="list-style-type: none"> • Focused on self-improvement and demonstrated a keen willingness to learn <i>Demonstrated a commitment to improving their skills, and apply new knowledge to patients</i> 	→ <i>Engaged in self-directed learning activities</i>
	<ul style="list-style-type: none"> • Exhibited leadership traits <i>Focused on identifying ways to improve their setting</i> 	→ <i>Assumed a capable and primary role in their workplace</i>
	<ul style="list-style-type: none"> • Adapted well to changes in workflow and circumstances 	<ul style="list-style-type: none"> • Strongly contributed to their team
	<ul style="list-style-type: none"> • Established self as a team player 	<ul style="list-style-type: none"> • Sought opportunities to elevate practice • Served as an educational resource • Perceived as a valuable contributor to their team
Communication with Other Healthcare Providers	<ul style="list-style-type: none"> • Built strong relationships with healthcare providers through communication <i>Utilized respectful, clear, and logical verbal and written communication</i> 	→ <i>Prioritized a partnership approach when interaction with healthcare providers</i>
	<ul style="list-style-type: none"> • Gained confidence, which resulted in effective interactions with healthcare providers <i>Growth in confidence allowed for organized communication</i> 	→ <i>Took initiative during rounds and engaged in intra-professional collaborations</i>
	<ul style="list-style-type: none"> • Exhibited strong presentation skills 	
Patient care	<ul style="list-style-type: none"> • Established self as a strong and trusted health partner through patient-centred communication <i>Developed a compassionate communication pattern with patients, asking useful questions to gather relevant information</i> 	→ <i>Quickly created a trusting relationship with patients, functioning as their advocate</i>
	<ul style="list-style-type: none"> • Strong intentional engagement, tailoring language and delivery to the patient 	

	<i>Explained complicated medical terms in easy, accessible language</i>	→ <i>Able to assess how a patient was feeling based on verbal and non-verbal cues, and changed their tone or terminology based on their perceptions of the patient's beliefs and level of understanding</i>
	<ul style="list-style-type: none"> • Gain in confidence allowed for more focused patient interactions <i>Displayed more comfort in their approach to asking questions to the patients, which led to a stronger engagement with patients</i> 	→ <i>Capably managed patient care discussions and decisions with little or no guidance</i>
		<ul style="list-style-type: none"> • Growth in ability to prioritize care across multiple patients with various medication-related issues
		<ul style="list-style-type: none"> • Good rapport led to comprehensive assessments • Strong therapeutic knowledge facilitated trusted recommendations for therapy changes
Additional observations	<ul style="list-style-type: none"> • Demonstrated financial competencies 	
	<ul style="list-style-type: none"> • Critical and logical thinking skills, therapeutic knowledge, and ability to solve problems were well beyond expectations 	

Exhibited traits of a leader (*co-op and rotations*): Students displayed natural leadership tendencies through their focus on the team as a whole, and during their co-op terms, identified strategies to improve workplace efficiency and patient safety, including proposing innovative approaches. Some students showed aptitude for a leadership role by engaging in activities that solidified others' perceptions of them as a leader. Such activities involved developing recommendations and creating initiatives that improved practice at their site, and leading rounds and other interprofessional meetings. Additionally, there were students who used their rotation to capably assume a more primary role in the pharmacy, including stepping in as needed to manage pharmacy staff and workflow, delegating tasks to technicians and assistants, and accepting more responsibility. Preceptors noted that there were a minority of students who still required guidance in assuming leadership activities and lacked self-assuredness in their interactions with their healthcare team perhaps due to not yet feeling confident enough in their abilities or experience. They recommended that these students take more initiative in pharmacy activities and collaborations to develop and strengthen their leadership skills.

Adapted well to changes in workflow and circumstances (*co-op*): Some supervisors commented on their students having to contend with unusual situations during their co-op term, such as medications requiring special authorization, significant medication recalls, and large network failures. The students adapted quickly and calmly to learn as much as possible and adjust workflow as needed. For a small number of co-op students, supervisors noted that refinement of time-management skills was needed, to be better able to handle high patient volumes and subsequently be equipped to assume a bigger caseload.

Established self as a team-player (*co-op*): Over the course of co-op terms, students grew in their ability to contribute to the team through endeavours such as active involvement in team discussions, supporting team members by taking on additional workload, and maintaining a high level of productivity to not adversely impact others. For these reasons, students were well-regarded by their team and the supervisors mentioned hearing that others enjoyed working with them because of their friendly demeanours and their competence, meaning their decision-making could be trusted.

Strongly contributed to their team (*rotations*): Preceptors remarked on students' ability to quickly integrate into the team by fostering relationships with other members and taking on additional responsibilities to help others ease their workload.

Sought opportunities to elevate practice (*rotations*): Students demonstrated their focus on contributing to better pharmacy practice by being visibly enthusiastic and discussing ideas to support their workplace. They also served as champions for broadening pharmacist scope and were excellent pharmacy representatives, advocating to other healthcare providers on the important role that pharmacists have on patients and communities and the benefits of having pharmacists on their team.

Served as an educational resource (*rotations*): Students were seen as a valuable teaching resource, providing training to pharmacy technicians and assistants and mentorship to other students. They utilized opportunities to share knowledge with others through presentations made to their team, other healthcare providers, as well as the community. They were recognized

by peers as an important source of information, commonly sought out when others had questions, and were also trusted to update pharmacy practice documents and procedures for the team.

Perceived as a valuable contributor to their team (*rotations*): Despite not yet being a practicing pharmacist, students completing rotations were increasingly viewed as professionals by their team because of their contributions and their willingness to collaborate. During rotations, students proved their abilities to the extent that their perspective was trusted and was supported by evidence, leading to healthcare providers seeking out the students for their input and recommendations.

Communication with other healthcare providers

Built strong relationships with other healthcare providers through communication (*co-op and rotations*): Students regularly engaged with other healthcare providers, particularly physicians, to discuss orders and identify and resolve drug therapy problems (DTPs). Such interactions could be in person, over the telephone, or via fax, and co-op students demonstrated respectful and clear verbal and written communications. In more challenging situations during rotations, such as when correcting prescribing errors, students displayed strong listening skills and adopted a non-punitive approach which served to maintain positive relationships. The qualitative feedback also indicated that some co-op students still required guidance regarding what to include and not include in their documentation, while a small minority of students were advised by their rotation preceptors to be more clear and confident in providing the rationale for their decisions and recommendations.

Gained confidence which resulted in effective interactions with other healthcare providers (*co-op and rotations*): Students exhibited greater confidence over the course of their co-op terms which was further cultivated in rotations, as demonstrated by taking initiative on a number of activities in which their knowledge and professionalism was displayed to other healthcare providers, such as asking questions during rounds, making presentations, and engaging in other forms of intra-professional collaboration. However, for a small group of students, supervisor and preceptors recommended that they demonstrate more confidence in their

abilities by speaking up more, to consider using an organization framework when speaking to ensure communications were well-organized and complete, and to be more assertive.

Exhibited strong presentation skills (*co-op*): Students often created or accepted opportunities to make presentations to others, such as members of the team or other healthcare providers, as a way of providing knowledge translation. During these presentations, students demonstrated confidence and were complimented on conveying information that was clear, targeted, and effective.

Patient care

Established self as a strong and trusted health partner through patient-centred communication (*co-op and rotations*): Many supervisors and preceptors commented on the meaningful relationships that students were able to independently establish with patients in the short duration of their co-op terms and rotations, respectively. Co-op students demonstrated care and compassion in their patient interactions, and further strengthened their ability to quickly build rapport with patients during rotations, even acting as advocates for them. This resulted in the common occurrence of patients asking for the student when they attended the pharmacy and expressing sadness when the student's WIL experience was ending. For a small number of students, suggestions were mentioned across the co-op terms and rotations to optimize students' effectiveness with patients. Many of these appeared to be actionable with more experience, such as speaking louder and exhibiting confidence when communicating, particularly with challenging patients. Additionally, when conducting interviews with patients, preceptors and supervisors emphasized the importance of taking initiative to proactively plan for follow-up.

Strong intentional engagement with patients, including tailoring language and delivery (*co-op and rotations*): Feedback indicated that students exhibited great communication with patients, capably navigating discussions and reading non-verbal cues. Co-op students used simple language, opting for clear terminology rather than medical jargon, and expressed empathy when assessing whether the patient understood the discussion, ably pivoting to other approaches and wording as needed, and even drawing pictures to help clarify the message. This strong patient care foundation was further advanced during rotations: several preceptors commented

specifically on the students' ability to communicate in special situations, such as with patients with mental health concerns, hearing impairments, or language barriers. Students consistently displayed that their primary goal was to ensure that their patients benefitted from every interaction. Preceptors expressed that, for some students, there was room for improvement in ensuring that communication was targeted to the patient, asking direct questions to identify patient goals and incorporate these goals into clinical decisions, and to be mindful of their own non-verbal language while paying attention to the patient's non-verbal cues.

Gain in confidence allowed for more focused patient interactions (*co-op and rotations*): Supervisors and preceptors mentioned multiple ways in which students improved over their co-op terms and rotations, respectively. Much of this was related to students being more confident and prepared during co-op terms, which impacted how they approached patients and adapted to patients' communication needs, with less guidance required during rotations.

Good rapport led to comprehensive assessments (*rotations*): Through both initial interactions and comprehensive follow-ups during their rotations, students were able to demonstrate many soft skills and high emotional intelligence by communicating in a manner that was comfortable and respectful, and during which they exhibited solid listening skills. Students showed good preparation for patient meetings and appointments, reviewing the patient's history and documentation from prior visits. Students asked questions and accepted responses in a non-judgmental tone to better understand patient goals, and involved family in discussions when they believed it would be beneficial to the patient. For a small number of students, preceptors proposed strategies to facilitate implementation of patient care plans such as being more clear, concise, and confident in communication, conducting a comprehensive assessment so that the resulting plan is thorough, and prioritizing patient education.

Strong therapeutic knowledge facilitated trusted recommendations for therapy changes (*rotations*): During their rotations, students were able to identify drug therapy problems (DTPs) and potential interactions, prioritize which need most immediate action, and provide rationale for changes and suitable recommendations that take into consideration patient factors, with little guidance.

Growth in ability to prioritize multiple patients with various medication-related issues (*rotations*): Students gained skills in prioritizing their workload, which allowed them to both handle high patient and prescription volumes and be realistic about what could and could not be done on a specific day. Preceptors remarked on improvement in students' time-management skills over the duration of the term, noting that students were better able to determine who should be seen and which tasks should be completed first. This prioritization resulted in the students working more efficiently and having enough time to ensure that all patients received adequate follow-up. They were also better equipped to support other pharmacists on the team. Some preceptors commented on students' ability to manage workloads similar in complexity and volume to a practicing pharmacist.

Additional observations

Demonstrated financial competencies (*co-op*): For many students, co-op work terms were opportunities to gain experience with the financial aspects of pharmacy, and the balance of business with clinical practice. They observed the impact of funding changes on the workplace's budget and gained an understanding of the financial aspects of pharmacy from both private and public payor perspectives.

Already demonstrates the skills of a pharmacist (*co-op*): A subset of co-op supervisors lauded the students for already showing that they are prepared to enter the workforce as a pharmacist, commenting that the students' critical and logical thinking skills, therapeutic knowledge, and ability to solve problems were well beyond expectations. These students also accepted more work and, in some cases, focused on improving practice including creating organizational workflows that benefited their coworkers, and made a stronger contribution to the team than initially anticipated. Some supervisors commented that they would be happy to hire the students as they already proved themselves to be great assets to the workplace.

5.5 Discussion

To identify co-op supervisors and rotation preceptors' perceptions of the job/practice readiness skills that students exhibited during each WIL experience, as well as the individual and synergistic value of these models in pharmacy, we conducted an evaluation of UW School of Pharmacy co-op supervisor and rotation preceptor feedback on student performance. Our analysis indicates that there is clear overlap in many of the skills that UW PharmD students learn and build through both co-op work-terms and final-year rotations, particularly with respect to providing direct patient care and applying therapeutic knowledge, each WIL experience also offers clearly distinct, complementary, and valuable experiences for students. As job-structured experiences, co-op work terms appear to support students in obtaining key foundational skills including time management, professionalism, and communication in a team environment. These skills are then both supplemented and further refined in the final-year rotations, during which student engagement in more advanced practice responsibilities and interactions cultivates their confidence and allows their views of themselves to evolve from being a student to a productive, competent, and valued member of a team. This knowledge of the skills cultivated by each WIL model may be of value to pharmacy schools around the world that are contemplating modification of their own curriculum.

Despite co-op work terms being completed in the students' second and third year of a four-year program, comments from supervisors indicate that students treated the experience as they would a job outside the WIL framework. Supervisors described students' eagerness, professionalism, and work ethic, with some expressing their willingness to subsequently hire the students. Results of recent UW Pharmacy Alumni Surveys (unpublished data) corroborate this sentiment, as more than half of respondents reported that at least one of their jobs since graduating had been with a previous co-op term employer (51% and 54% in 2018 and 2022, respectively). Our analysis indicates that students appear to approach their co-op work terms with a sense of responsibility and desire to be useful and contributory, perhaps due to the "real-world" reciprocal structure of the co-op model where they are being paid to complete tasks and assume responsibilities set forward by the employer. Prior research of student perceptions of co-op programs indicate that these learning experiences foster a sense of affective commitment, whereby the student feels emotional attachment to the employing organization due to an alignment of their

own personal characteristics and their work experience, resulting in a desire to remain with the company.²⁰ It is conceivable that students view co-op as a trial period, operating with an overarching awareness that if they meet and exceed the employer's expectations, they may be able to secure future employment there post-graduation. Compared to rotations that are part of an IPPE or APPE model, co-op work terms are also longer in duration (4 months) and may therefore allow more time for students to immerse themselves in the setting, take on various tasks and responsibilities, and have more opportunity to learn and refine job readiness skills. Late-stage rotations, in contrast, were developed to impart a very specific set of skills related to their ability to act as independent healthcare providers.²¹

Similar to APPEs, rotations are completed in the final year of the UW PharmD program when the majority of students' didactic learning is complete, offering a final opportunity for students to practice skills under supervision prior to entering practice. Preceptor feedback indicates that students are more secure in their skills as a pharmacist at the end of rotations, demonstrating abilities beyond those assessed by the OPPCAT and engaging in activities that indicate their commitment to enhancing pharmacy practice by contributing to their team and teaching and guiding others. The combination of earlier co-op followed by late-stage rotations appears to translate to the latter experience fostering the building of students' confidence in their professional identity, building upon foundational professional attributes that began forming during the co-op work terms. This discovery of self has been previously described as a primary goal of WIL programs.²² Pharmacy schools that are considering the addition of a co-op component to their program may find the scaffolding of skills provided by co-op work terms to be of considerable value to their students in their progression to job/practice readiness.

Prior research has examined areas where pharmacy students and new graduates feel most and least prepared for practice.²³ Areas where coursework and independent learning are likely to provide a sufficient level of knowledge (i.e., understanding health conditions and associated treatment options, pharmacy regulations) are typically associated with greater confidence. Students have also indicated that they felt prepared for patient counselling and technical activities such as dispensing.²³ However, feelings of unpreparedness arose when communicating with challenging patients, assuming a leadership role, managing relationships, working as part of a multidisciplinary team, and practicing within a busy/fast-paced environment.²³ More in-depth

exploration has found that during WIL experiences, pharmacy students often vacillate between feelings of preparedness and lack of preparedness, particularly as they navigate both patient management and time management in pharmacy settings. Such skills are considered only learned through exposure and application, and its therefore unsurprising that traditional coursework would not impart them. Based on comments from UW PharmD co-op supervisors and rotation preceptors, being able to prioritize and work efficiently to optimally manage one's time while consistently portraying a calm and confident presence are aspects of pharmacy practice that all students should continue to be mindful of, but that many already exemplified, likely facilitated by the combination of three co-op work terms and three final-year rotations.

Interpretation of our findings requires acknowledgement that while co-op supervisors and rotation preceptors are required to provide numerical evaluations of students' performance, offering qualitative feedback is optional and therefore not completed for every student. Approximately 91% of students' co-op work terms and rotations included some qualitative feedback. Additionally, although instructions for specific and constructive feedback were provided, it was at the discretion of the evaluator whether they provided feedback at all, and if so, how much. Therefore, feedback was focused on what the supervisors and preceptors deemed noteworthy to highlight. This paper does not link quantitative scores and qualitative feedback or consider associations with workplace characteristics, student performance within academic terms, or demographic characteristics of students or supervisors/preceptors; such analyses is beyond the study's intended scope. Finally, the analysis timeframe was 2017-2019, in order to include a fairly consistent and recent curricular window, while avoiding the pandemic years, during which WIL programs operated quite differently compared to more routine years. While there have been ongoing changes in pharmacy practice and education, there have not been major shifts in experiential program structure and requirements in the UW PharmD program, beyond more opportunities allowing hybrid work schedules. It can therefore be expected that the results can still be considered representative of the current program.

5.6 Conclusions

Our analysis demonstrates that, based on the perceptions of co-op supervisors and rotation preceptors, each WIL experience offers UW PharmD students multiple job/practice readiness skills that prepare them for the various facets of a career as a pharmacist. Specifically, gaining skills such as professionalism and communication through the co-op work terms allows students to orient themselves to functioning on healthcare teams, preparing them for more advanced, focused, and nuanced patient care skill development during rotations in the final year of the program. Future work will focus on viewing these WIL models through the student lens to capture how these experiences contribute to their perceived sense of preparedness for entering practice.

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Chapter 6

Entrustable Professional Activities (EPAs) for Pharmacy Students During Experiential Education: A Comparative Analysis

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References for this published section have been kept at the end of this chapter, subsection 6.7

6.1 Overview

Introduction

Entrustable Professional Activities (EPAs) have gained traction in competency-based education and training. This study explored pharmacy student, supervisor, and preceptor perceptions of EPAs as compared to existing assessment tools within a pharmacy program that uses a co-operative education (co-op) and clinical rotation model for experiential education.

Methods

University of Waterloo PharmD students and their co-op supervisors or rotation preceptors used an EPA-based assessment tool alongside existing evaluation methods during experiential placements. Surveys collected qualitative and quantitative data on the perceived strengths and limitations of EPA use. Two researchers independently coded qualitative feedback using content analysis to identify themes related to performance evaluation and job and practice readiness.

Results

Students appreciated the EPA tool's real-world relevance and emphasis on autonomy but raised concerns about its grading clarity and applicability, particularly in the co-op settings that involved less direct patient care. Supervisors and preceptors found the tool practical and focused on the independence element but noted the importance of being trained on its use and challenges with rating consistency. A hybrid model integrating EPAs with current tools was preferred by many participants to balance clinical task assessment with broader competency evaluation.

Discussion

EPAs were perceived as valuable in assessing student autonomy and readiness for unsupervised practice, especially during clinical rotations. However, alignment challenges with co-op responsibilities and evaluator variability may limit their standalone use. A combined assessment approach may offer a more comprehensive and context-sensitive evaluation of student performance during experiential training.

6.2 Introduction

As pharmacy education evolves to meet the demands of an increasingly complex healthcare landscape, ensuring that students are equipped with the necessary skills for practice is paramount. One effective strategy for bridging the gap between theoretical knowledge and practical application is work-integrated learning (WIL). WIL allows students to gain hands-on experience in real-world settings, with rotations and co-operative education (co-op) serving as key components in pharmacy programs¹. Rotations, which are a well-established form of WIL, involve unpaid placements in various settings where students gain practical experience in pharmacy practice². In many North American pharmacy programs, these include earlier Introductory Pharmacy Practice Experiences (IPPEs) and, later, more advanced clinical rotations known as Advanced Pharmacy Practice Experiences (APPEs). In contrast, co-op education is a distinctive WIL model that alternates traditional academic learning with paid work placements in settings such as patient care environments, health policy, research, academia, and corporate workplaces. This model aims to enhance students' readiness for practice by immersing them in professional settings where they can apply their academic knowledge, build practical skills, and develop competencies necessary for effective pharmacy practice.^{3,4,5}

Although WIL has proven beneficial, a universally accepted framework for assessing pharmacy graduates' readiness for practice has yet to be established. This gap has led to the widespread adoption of competency-based education and training (CBET), which ensures graduates meet clearly defined competencies required for practice.⁶ One approach to assessment in CBET is the use of Entrustable Professional Activities (EPAs), defined as units of professional practice that a trainee can perform unsupervised once they have demonstrated sufficient competence.⁷ EPAs focus on workplace-based assessments (WBAs), which allow for frequent formative feedback and observation, helping learners refine their skills over time.⁸ In pharmacy education, EPAs are aligned with the Pharmacist Patient Care Process (PPCP), which encompasses the core responsibilities pharmacists undertake in practice: collect, assess, plan, implement, and follow up on patient care.⁹

While CBET frameworks are widely implemented in Canadian pharmacy curricula, EPAs have not yet been adopted to the same extent, and have primarily been implemented in medical education and training. Although CBET provides a general structure for assessing competencies,

EPAs offer a more targeted approach, focusing specifically on assessing a student's ability to perform key tasks autonomously and unsupervised. In Canada, the Association of Faculties of Pharmacy of Canada (AFPC), National Association of Pharmacy Regulatory Authorities (NAPRA), and the Canadian Council for Accreditation of Pharmacy Programs (CCAPP) outline core competencies and educational outcomes for pharmacy graduates, aligning curricula with competency-based models. For example, the AFPC and NAPRA frameworks ensure that pharmacy graduates are prepared to meet entry-to-practice standards across diverse healthcare settings.^{10,11,12}

In 2023, the American Association of Colleges of Pharmacy (AACCP) identified 13 core EPAs for pharmacy graduates, which are designed to be assessed across both didactic and experiential settings to ensure that students are adequately prepared for unsupervised practice.^{9,13} Ten of these EPAs align with the full spectrum of the PPCP process, with EPAs 1 and 2 focusing on patient data collection and assessment, EPAs 3 through 5 targeting care plan development, EPAs 6 through 8 addressing the implementation of patient care plans, and EPAs 9 and 10 dedicated to follow-up care and monitoring.^{9,13} While these EPAs provide a structured method for assessing pharmacy students, the extent to which they can complement or replace traditional assessment tools, particularly in experiential settings such as co-ops and rotations, remains an underexplored area.^{9,13,14}

The University of Waterloo PharmD program is one of only two pharmacy schools in North America to incorporate a co-op model, where students alternate between paid work terms and in-class academic learning. Co-op is employed in years 2 and 3 of the 4-year program with traditional rotations embedded in the final year. A summary of the School of Pharmacy's two WIL models and associated assessments is presented in Table G-6.1.

Table G-6.1. University of Waterloo PharmD Program WIL Models

Characteristic	Co-op Work Terms	Patient Care Rotations
Time of completion during 4-year program	Years 2-3	Year 4
Number of terms/rotations	3	3
Duration of each term/rotation	16 weeks	8 weeks
Student selection/assignment process	All pharmacy students are in a co-op program. Mandatory for all students to apply/interview for preferred positions for school-recruited positions or self-arrange placements. Interview process mirrors real-world hiring and supports mutual fit assessment.	Random assignment
Sites	Primary care, institutional care, technology companies, corporate head offices, government, and research or academic organizations	One institutional setting, one primary care setting, and a third rotation being either an additional institutional or primary care placement
Skills gained	Responsibilities vary depending on setting and job description	Patient care skills
Geographical location	Anywhere (including international sites)	Assigned region within Ontario
Rubric(s) used for assessment	<ul style="list-style-type: none"> • Inventory of Skills Evaluation (Appendix 4C): Assesses four competencies: communication, professionalism, medication distribution, and direct patient care. Students must meet distribution and direct patient care competencies during at least one of their three co-op work terms • Co-op Performance Evaluation (Appendix 4D): assesses 16 attributes and skills that are indicative of how well the student conducts themselves and performs the duties assigned at their co-op setting. • Learners may complete a self-assessment using each rubric prior to the employer to compare perceived and employer-assessed performance. 	<ul style="list-style-type: none"> • Ontario Pharmacy Patient Care Assessment Tool (OPPCAT) (Appendix 5A) Assesses five core skills and competencies that pharmacy students must demonstrate to show readiness to practice: patient care, communication and education, professionalism, professional collaboration, and practice management • Learners may complete a self-assessment using the rubric prior to the preceptor to compare perceived and preceptor-assessed performance.
Grading Outcome	<ul style="list-style-type: none"> • Credit/No Credit 	<ul style="list-style-type: none"> • Credit/No Credit • Midpoint and final assessments are graded; students are awarded Credit if the combined score meets the internal threshold of 70% • A-E rating scale: C = 70% (minimum pass), D ≈ 85%, E = 100%
Financial compensation to students	Yes; salary from the employer may range from \$19/hour to \$40/hour	No

Currently, student competencies in patient care are assessed during rotations using the Ontario Pharmacy Patient Care Assessment Tool (OPPCAT), a province-wide tool used in pharmacy education and residency programs. However, this tool primarily emphasizes clinical tasks and may insufficiently capture broader professional competencies such as autonomy, confidence in clinical decision-making, and readiness for independent practice. Similarly, co-op work terms are evaluated through performance reviews and skill inventories that focus on task completion rather than on the development of professional judgment or the ability to practice unsupervised. Separately, the current assessment frameworks may not fully reflect a student's progression toward practice readiness. However, EPAs, which are designed to assess whether learners can be trusted to perform key tasks independently, may offer a more comprehensive approach. By focusing on both clinical competence and the integration of skills, knowledge, and judgment, EPAs may provide a more holistic view of student readiness across both co-op and rotation experiences.¹⁵ This study aims to explore the perspectives of students, preceptors, and supervisors regarding feedback quality and their understanding of student performance using EPAs versus current assessment methods.

6.3 Methodology

6.3.1 Study design

We employed a mixed-methods survey consisting of both multiple-choice and open-ended questions to explore the perspectives of University of Waterloo PharmD students and their co-op supervisors and rotation preceptors on the utility of EPAs in comparison to existing experiential education assessment forms to evaluate student performance during their WIL.

6.3.2 Recruitment

Pharmacy students who were on direct patient care co-op work terms from January to April 2024 or May to August 2024 or were on rotation placements from February to April 2024, April to June 2024, or June to August 2024 were eligible for the study. During the study period, a total of 360 unique learners were eligible to participate, comprising two co-op cohorts (Winter and Spring; n = 240) and one rotation cohort (n = 120). Actual learner participation included 21

students (7 co-op and 14 rotation). Two months prior to the term's start, students and their supervisors/preceptors were contacted via email by the study team, which described the study objectives and responsibilities and invited them to participate. If supervisors/preceptors agreed to participate, they were sent a consent form to complete for themselves, along with a separate consent form for their associated student(s) to fill out. Once both the supervisor/preceptor and their associated student completed the consent forms, they were considered enrolled in the study.

All dyads (comprising a pharmacy student and their co-op supervisor or rotation preceptor) that agreed to enroll in the study and provided informed written consent received online training materials to provide them with background on EPAs as well as the list of 13 core pharmacy EPAs with examples of PharmD student tasks that demonstrate each activity. The training materials were part of the orientation process for both students and supervisors/preceptors to familiarize them with the EPA tool.

6.3.3 Data Collection

At the mid-point and end of each of the co-op terms and rotations, supervisors and preceptors utilized the EPA tool (Appendix 6A) to assess the students. This competency-based assessment evaluated the level at which a student could be entrusted to complete 13 pharmacist tasks and responsibilities, based on the amount of supervision required:

- i. **Observe only:** Learner is permitted to observe only. Even with direct supervision, learner is not entrusted to perform the activity or task.
- ii. **Direct Supervision:** Learner is entrusted to perform the activity or task with direct and proactive supervision. Learner must be observed performing task in order to provide immediate feedback.
- iii. **Reactive Supervision:** Learner is entrusted to perform the activity or task with indirect and reactive supervision. Learner can perform task without direct supervision by may request assistance. Supervising pharmacist is quickly available on site. Feedback is provided immediately after completion of activity or task.
- iv. **Intermittent Supervision:** Learner is entrusted to perform the activity or task with supervision at a distance. Learner can independently perform task. Learner meets with supervising pharmacist at periodic intervals. Feedback is provided regarding overall performance based on sample of work.
- v. **General Direction:** Learner is entrusted to independently decide what activities and tasks need to be performed. Learner entrusted to direct and supervise activities of

others. Learner meets with supervising pharmacist at periodic intervals. Feedback is provided regarding overall performance based on broad professional expectations and organizational goals.

Co-op supervisors and rotation preceptors completed the EPA assessments and reviewed the resulting ratings with students at midpoint and final evaluations. Through these structured feedback discussions, students became familiar with the EPA content, rating scale, and expectations for progression, despite not completing the tool as a formal self-assessment.

Supervisor and preceptor completion of the EPA assessment was in addition to the current UW PharmD assessment forms described in Table G-6.1. Once completed, co-op supervisors and rotation preceptors were instructed to submit their EPA evaluations to the appropriate university online repositories. All supervisors and preceptors received a Qualtrics link to complete the midpoint and final EPA assessments one week prior to their respective due dates, as well as a reminder email the day after the due date if not already submitted. At the end of the study period, supervisors, preceptors, and students were sent a final Qualtrics feedback survey, which gathered perspectives on the strengths and weaknesses of using EPAs compared to the existing assessment methods. Survey links were distributed one week before the due date, and if not completed by then, participants were reminded the following day to complete it. To accommodate late submissions, all assessment and survey links remained open for one additional week past the due date.

6.3.4 Analysis

All collected data were de-identified to remove names, student numbers, and any other potential identifiers prior to analysis by an individual who was not a member of the research team.

Quantitative data from the EPA tool feedback survey were analyzed descriptively to summarize the participants' responses, while content analysis was used to analyze the text responses. This content analysis focused on the participants' perspectives on the assessment tools being used. Two members of the research team (AS [male pharmacist and researcher] and JP [female healthcare researcher]) independently coded 25% of the comments inductively, and then collaborated on a single coding dictionary which they used to each code the remainder of the

data. Throughout the process, they consulted with each other on updates to the dictionary to ensure cohesion, discussing all discrepancies in coding until consensus was reached. Following the coding stage, AS and JP arranged the codes and grouped them into themes and sub-themes.

All analyses were conducted in Microsoft Excel 2021 version 2308 (Microsoft Corporation).

6.3.5 Research Ethics

Approval was obtained from the University of Waterloo Research Ethics Board (ORE #45676).

All study participants received Amazon gift cards as compensation.

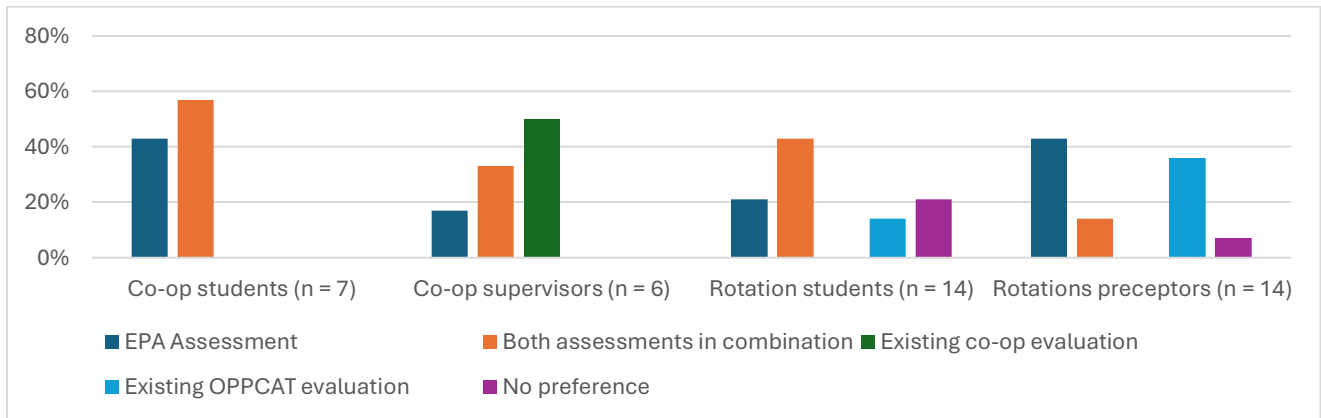
6.4 Results

During the study period 7 co-op dyads and 14 rotation dyads participated. Of the co-op students, 4 were in Year 2 (57%) and 3 were in Year 3 (43%) of the four-year program. For the students on rotations, 3 were on the first rotation of the program (21%), 8 were on their second rotation (57%) and 3 (21%) were on the final rotation. 10 of the 14 students were completing rotations in a primary care site (71%), and 4 (29%) in an institutional setting. All participants provided at least one open-ended survey response in the final feedback survey. However, not all participants responded to every question, and some responses were incomplete or truncated, resulting in variable response completeness across items.

Students' preferences for WIL assessment tools

When asked about their preference for WIL assessment tools, all co-op students opted for use of the EPA tool either on its own (43%) or in conjunction with the existing two co-op assessments (57%) to assess student performance (Figure C-6.1). Responses from the students on rotations were more varied, with the most common response being the hybrid approach of both the EPA tool and the OPPCAT together (43%).

Figure C-6.1. Student, supervisor and preceptor preferences for WIL assessment tools*



*one individual provided co-op supervision to two students

Strengths

The qualitative analysis of open-ended EPA tool feedback indicated that students completing co-op work terms and rotation placements found several shared strengths of the EPA tool:

- i. **Real-world relevance and clinical focus:** The EPA was valued by students for reflecting real-world pharmacist roles and aligning well with patient care tasks and the PPCP process. It was viewed as offering meaningful and applicable practice-based assessment with the example tasks making it easy to navigate and complete, as demonstrated by the student comment below.

“Additionally, the EPAs that we are evaluated on are more specific and get into actual tasks that pharmacists will perform, instead of just being evaluated on our professionalism or communication with the OPPCAT.” (rotation student)

- ii. **Empowerment and independence:** Students felt that the EPA promotes autonomy and confidence in clinical judgment, fostering empowerment and self-directed learning. They appreciated how EPA assesses increasing levels of independence and provides feedback that supports confidence and professional growth, as indicated by the student comment below.

“The EPAs and associated example tasks are easy to compare to what we are actually doing in practice as a coop student, therefore it is easy to answer and select the appropriate level on the

EPA scale. Additionally, the levels allow to see the progression from assessing at the beginning of the coop term and then end.” (co-op student)

Challenges

Students also identified several challenges with using the EPA tool to assess student performance during their co-op work terms and rotation placements:

- i. Grading and fairness concerns:** Students were concerned that the tool penalizes them for collaborating with preceptors/supervisors or seeking their feedback, rather than performing tasks completely independently. They also expressed that tool was unclear and ambiguous in how student performance translates into a grade.
- ii. Limited tool applicability:** EPAs were considered flexible across different types of rotation and co-op sites, but students note that it is not always tailored to the specific tasks and scope of responsibilities of their WIL experiences, reducing its relevance and fairness in some contexts, as demonstrated by the following student comment.

“A weakness in being assessed with the novel EPA assessment tool is that some entrustable activities are difficult to answer because they are very specific especially for a student that is only working on best possible medication histories.” (co-op student)

Concerns

A few concerns were identified by students specific to the use of the EPA tool for rotation placement evaluation:

- i. Lack of clarity and usability:** While the tool was generally considered easier to follow than current tools, students reported confusion around entrustment levels and found some competencies to be too specific to be applicable or redundant.
- ii. Subjectivity and inconsistency:** Students perceived that the tool could lead to subjectivity in assessments across preceptors, resulting in inconsistencies in evaluating autonomy and competence, as illustrated by the comment below.

“With the novel EPA assessment tool our level of autonomy is assessed but not our performance/how well we did. For example a task may be completed with supervision which would be categorized as ‘intermediate supervision’ via the EPA assessment tool but how well we

performed that task isn't captured with the tool. This task under 'intermediate supervision' may have been performed exceptionally well or poorly but both would be graded as 'intermediate supervision'." (rotation student)

Co-op students also identified potential issues with the use of the EPA tool to evaluate student performance specific to their co-op work terms:

- iii. **Complexity and over-specificity:** Students felt that the tool was too detailed or advanced for use at the co-op level, with some activities or competencies not aligned with the responsibilities of co-op jobs for PharmD students.
- iv. **Lack of supervisor-directed feedback:** Students noted that the EPA tool did not include a mechanism for students to provide feedback on their co-op employers, which they felt would have been useful.
- v. **Increase in supervisor workload:** Completion of the EPA tool could result in supervisor burden, especially if it is added to their current evaluation process which includes the Inventory of Skills Evaluation as well as the Co-op Student Performance Evaluation.

Students who preferred the hybrid approach of the EPA tool in combination with the currently existing assessment forms felt that this method would leverage the detailed and task-specific nature of the EPA's autonomy assessment, and offer a more well-rounded evaluation.

Co-op supervisor and rotation preceptor preferences for WIL assessment tools

While preferences varied, rotation preceptors were more likely to indicate a preference for the EPA tool over the existing assessments (43% vs. 36%), compared to co-op supervisors (Figure C-6.1).

Strengths

Qualitative assessment of the survey identified EPA tool strengths recognized by both co-op supervisors and rotation preceptors:

- i. **Practicality and ease of use:** The EPA tool was observed to be quick, efficient, and easier to use compared to existing assessments to evaluate student performance.

- ii. **Focus on student autonomy:** Preceptors and supervisors appreciated the tool’s emphasis on assessing independence and readiness for practice, which was viewed as especially beneficial for students completing their final work terms and placements, as demonstrated by the select preceptor comment below.

“I found it to be simpler and easier to follow and more relevant criteria compared to the OPPCAT tool.” (rotation preceptor)

Challenges

Supervisors and preceptors also identified several weaknesses of the EPA tool:

- i. **Need for training and examples:** The grading scheme and task breakdown of the EPA were viewed as unclear. Both preceptors and supervisors expressed the need for more examples, training, and definitions to ensure the consistent and effective use of EPA and increase the clarity of the assessment.
- ii. **Risk of bias and misinterpretation:** Preceptors and supervisors identified that the evaluator’s personal comfort with student autonomy and independence would be a considerable influence on their EPA ratings, which could lead to inconsistent assessments, as demonstrated by the select supervisor comment below.

“More examples of the behaviour and tasks associated with each level would be helpful, otherwise preceptors completing the assessment may have different interpretations and definitions of the level of supervision. This is a user bias risk inherent to any evaluation tool and thus increased training on the tool can be helpful to mitigate this.”(co-op supervisor)

- iii. **Limited scope and relevance:** There was concern that the EPA's focus on patient care may not align with all rotation tasks or fully reflect the tasks performed by co-op students (e.g., best possible medication history [BPMH] or medication reconciliation).

A combined approach using both EPA and existing assessment tools was preferred by a subset of respondents to balance independence assessment with competency-based evaluation and task-specific skills

6.5 Discussion

This study explored the perceptions of pharmacy students and their respective supervisors and preceptors with respect to the utility of EPAs as an alternative or complementary assessment tool during WIL experiences. Co-op students strongly favored using the EPA tool, while rotation students showed more varied preferences, with many supporting a hybrid model combining EPA with existing assessments. Preceptors and supervisors similarly acknowledged the EPA's value in promoting student autonomy and practical relevance, but raised concerns about grading clarity, consistency across evaluators, and the tool's applicability to all practice settings. To our knowledge, this is among the first Canadian pharmacy education studies to evaluate EPA utility across these two distinct WIL contexts. This work contributes to a growing body of literature emphasizing the need to contextualize EPA implementation based on the structure, goals, and scope of the learning environment.^{16,17}

A major strength of the EPA tool identified by both co-op and rotation student participants was its alignment with authentic pharmacy practice. Students appreciated that EPA-based assessments reflected real-world pharmacist responsibilities, particularly in areas involving direct patient care, medication management, and clinical decision-making. This finding aligns with literature in health professions education, which emphasizes EPAs as a means to link assessment directly to real-world professional tasks and to foster practice readiness.^{18,19} For rotation students in particular, EPAs provided a structure that enabled them to demonstrate autonomy, clinical reasoning, and readiness for unsupervised practice, which are core goals of CBET. The progressive nature of EPA-based assessment, which supports increasing levels of entrustment over time, was seen as valuable for supporting both learning and evaluation in the workplace.

Support for EPAs was not uniform across placement types, as co-op students, in particular, raised concerns about the applicability of some EPAs to their workplace experiences. Given their varied settings and scope and earlier timing within the program, co-op placements may involve administrative, technical, or project-based activities, such as drug information research, quality assurance audits, or policy writing, which may not map directly onto patient-care-oriented EPA domains. This perceived misalignment led some co-op students to find certain EPA tasks either overly advanced or irrelevant to their responsibilities, which in turn affected

both the validity of the assessment and their engagement with the tool. These findings are consistent with broader concerns in the literature that standardized EPA sets, often derived from clinical competency frameworks, may not fully reflect the diversity of student responsibilities in non-traditional or early-practice settings.^{20,21}

Another commonly reported challenge was the subjective nature of EPA assessments. Co-op and rotation pharmacy students, supervisors, and preceptors expressed uncertainty in interpreting EPA rating scales, particularly with respect to autonomy and the degree of supervision required. Differences in perceived autonomy expectations between students and their evaluators, as well as variability in expectations across supervisors and preceptors, may further contribute to inconsistency in assessments. This aligns with findings from Al-Diery et al., who reported a lack of consensus among registered pharmacists regarding expected levels of supervision at defined milestones and a tendency for trainees to perceive themselves as more entrustable than their supervisors do.²² This also corroborates prior findings in medical education, where studies have documented ambiguity and variability in entrustment decisions, especially in the absence of rater training.^{21,23} The use of narrative feedback and self-assessment, while offering opportunities for reflection, also raised concerns about consistency, fairness, and transparency in grading. These concerns echo existing critiques of WBA, which highlight how rater experience, context, and personal judgment can impact assessment reliability.²⁴

A key insight from this study was a strong preference among student participants, supervisors, and preceptors for a hybrid assessment model. Rather than replacing existing assessment forms, participants suggested integration of EPA-based evaluations. EPAs were valued for assessing higher-order clinical behaviors and autonomy while existing tools were seen as better suited to capturing foundational or task-specific behaviors, particularly in the co-op context. This recommendation aligns with calls in the literature for programmatic assessment models that integrate multiple complementary tools to achieve a more comprehensive and context-sensitive evaluation of learner performance.^{25,26} Effective integration within a single hybrid assessment could help reduce the administrative burden on supervisors and preceptors, who noted that completing multiple EPA forms could be time-consuming, especially in co-op placements where the tool was less applicable.

Participants also identified several implementation challenges specific to the EPA tool. Supervisors and preceptors expressed a need for clearer instructions, examples, and training on how to use the tool effectively. Some communicated concern about the risk of bias or misinterpretation in the absence of shared understanding of entrustment scales. These concerns reinforce the importance of providing assessor training and support, a well-documented factor in improving the validity and utility of EPA implementation.¹⁹

Further work is needed to adapt EPAs to better reflect the competencies developed in co-op placements that do not involve direct patient care. This could involve the creation of co-op-specific EPAs or expanding existing EPA frameworks to include tasks related to policy development, systems-based practice, and administrative responsibilities. Research may explore how targeted training for assessors impacts the consistency and fairness of EPA ratings, ensuring that such training does not require extensive time commitments from assessors, as this could be a limiting factor. Finally, while EPAs have been implemented in some North American pharmacy programs, there are limited longitudinal studies linking EPA performance to downstream outcomes such as readiness for licensure, postgraduate success, or early career performance, which would offer important insights into the predictive validity of EPAs and their role in preparing pharmacists for professional practice.

6.5.1 Limitations

Our study was not without its limitations. First, the sample size was relatively small, which may reflect the demanding schedules of co-op supervisors and rotation preceptors, as well as hesitancy to engage with an additional assessment tool. As such, the findings may not be generalizable to all PharmD students or experiential education stakeholders within our program. While efforts were made to ensure balanced representation, the number of co-op students and supervisors was smaller than the rotation group, which may have influenced the strength of themes emerging from qualitative data. Additionally, data were collected from a single institution with a unique co-op-integrated program, which may limit the generalizability of findings to other pharmacy programs with different curricular structures or assessment practices. Participation in the study was voluntary and relied on self-reported data, and while the mixed-methods design offered rich insights, there was no formal mechanism to ensure qualitative feedback was received from all evaluators, and the relationship between quantitative and qualitative data was not

explored in depth. This limits the ability to triangulate the data and fully understand how perceptions aligned with ratings. Students' perceptions of the EPA tool may have been influenced by how supervisors or preceptors applied the assessment during evaluation, although this effect was likely limited because students were explicitly informed that EPA ratings collected for the study were not used for grading purposes. Furthermore, the limited training and integration of the EPA tool within and across the curriculum may have contributed to a lack of familiarity with this assessment approach, potentially affecting participant engagement and feedback. Future studies may consider integrating these elements to strengthen interpretation.

6.6 Conclusions

This study demonstrates the value of EPAs as a meaningful addition to existing assessment frameworks in a pharmacy program. A hybrid model that combines EPAs with traditional tools was perceived by students and their supervisors/preceptors to strike a balance between authenticity and practicality. Future research may focus on adapting EPA frameworks for non-clinical settings, improving rater training to ensure consistency, and conducting longitudinal studies to assess the long-term impact of EPAs on new pharmacist readiness to practice.

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Chapter 7

Discussion and Conclusion

The references for this chapter are located at the end of Chapter 7, subsection 7.11, alongside the references from Chapter 1-3.

7.1 Overview

This thesis provides valuable insights into the effectiveness of both existing and alternative assessment methods within the UW PharmD program, while identifying key factors that influence practice readiness among PharmD students. Each chapter addresses novel questions and contributes to an understanding of experiential learning, particularly within a co-op education model, which has not been extensively explored in existing literature. By examining the unique features of this model, this thesis offers new perspectives on the associations between WIL experiences and the preparation of students for entry-to-practice milestones and the pharmacy profession.

The research in **Chapter 4** explored associations between UW PharmD students' course grades and evaluations with success on key entry-to-practice milestones, including performance on final-year clinical rotations and the PEBC Pharmacist QE. This chapter is significant for several reasons. First, there is a notable gap in research on the relationship between student performance in pharmacy programs and success on entry-to-practice milestones in Canadian pharmacy schools and among those with a co-op education model. This study addresses this gap by being the first to investigate how co-op evaluations, academic performance, and clinical rotation assessments interact to influence milestone success in the context of the UW PharmD program. Second, by employing a multiple regression analysis and integrating descriptive statistics, the research examined how these variables correlate across three graduating cohorts. This allowed for a comprehensive understanding of which factors may be associated with success, thus providing insights into how underperforming students might be identified for further support, while recognizing that causal relationships cannot be inferred. Third, the findings point to specific areas within the curriculum that may require further evaluation and

adjustment to ensure alignment with practice-readiness standards. Lastly, this quantitative approach adds an important layer to the current literature, offering a data-driven method for identifying critical factors that influence entry-to-practice success.

Following the exploration of performance metrics in **Chapter 4**, **Chapter 5** took a deeper qualitative approach by investigating the perceptions of co-op supervisors and clinical preceptors regarding students' job and practice-readiness skills. This chapter was pivotal for three main reasons. First, while clinical rotations have long been a staple in pharmacy education, relatively few programs integrate co-op placements as part of their curricula. As such, there is a gap in the literature regarding the complementary and distinct roles that these two experiential learning models play in shaping practice-readiness. The findings from this study contribute to filling this gap by offering a comparative analysis of the skills fostered in both types of placements. Second, this research highlighted how foundational skills were described and emphasized over time within co-op experiences, which are essential for job readiness. These skills, which include professional communication, time management, and problem-solving, are foundational to the practice-readiness process and were perceived as relevant to preparation for more specialized and focused clinical training in their final-year rotations. Third, the research provided a unique opportunity to assess supervisor and preceptor perceptions across a broad spectrum of placement settings, encompassing both direct patient care and non-clinical roles. This diversity of perspectives added depth to our understanding of how various types of experiential learning experiences contribute to students' overall professional development and readiness for the complexities of pharmacy practice.

The first three objectives of this thesis were based on retrospective quantitative and qualitative data from the 2017-2019 graduating cohorts. As such, it was crucial to gather and analyze current student experiential performance data. In **Chapter 6**, the use of EPAs in conjunction with traditional UW PharmD experiential assessment tools was explored, providing insights into how these innovative assessment frameworks could enhance the evaluation of practice-readiness in pharmacy students. EPAs, which have gained prominence in CBE, are designed to assess students' ability to perform specific, high-level tasks within a professional setting. While EPAs have been increasingly adopted in healthcare education, their application in pharmacy education remains underexplored. This study contributes preliminary, exploratory

insights by investigating how EPAs could complement existing assessment methods, such as co-op evaluations and clinical rotation assessments, providing a more holistic, context-sensitive view of students' progress toward practice-readiness. The findings suggest that while traditional experiential evaluations remain an important component of assessing student performance, they may not fully capture the nuanced development of a student's readiness to enter the workforce. By incorporating EPAs, the study highlights the potential, rather than established utility, for a more comprehensive assessment approach that considers the broader range of skills developed through both co-op and clinical experiences. This research provides a hypothesis-generating, foundational step for future studies that could further explore how EPAs can be tailored to the pharmacy context, ultimately advancing the field's understanding of CBE and practice-readiness assessments.

Throughout this thesis, the use of a combination of quantitative and qualitative research methods has provided a robust framework for examining the complexities of experiential learning within the UW PharmD program. The research contributes new insights into how co-op education and clinical rotations work together to foster practice-readiness and the skills necessary for success in the pharmacy profession. This dual approach, linking academic performance, co-op evaluations, and clinical assessments, has not only advanced our understanding of the relationship between experiential learning and entry-to-practice success but also paved the way for further research into the effectiveness of alternative assessment methods. By identifying gaps in existing assessment frameworks and highlighting the complementary nature of co-op and clinical learning experiences, this study lays the groundwork for future investigations that can refine and improve the ways in which pharmacy programs assess and promote practice-readiness.

7.2 Interpretation of Findings and Gaps in the Context of Existing Research

Experiential learning remains a cornerstone of pharmacy education, offering students the invaluable opportunity to apply theoretical knowledge in real-world healthcare settings. This thesis specifically examines the integration of co-op education and clinical rotations within the UW PharmD program, shedding new light on how these two forms of WIL contribute to

students' overall practice-readiness. By doing so, it enriches the broader discussion of WIL in healthcare education, especially pharmacy, where the body of research is still evolving. This section contextualizes the findings within the current literature, while also identifying key gaps that remain in understanding the nuances of practice-readiness in pharmacy students.

7.3 Co-op Education in Pharmacy

Co-op education in pharmacy has been relatively underexplored in the literature, particularly when compared to clinical rotations. Most existing research on co-op education comes from disciplines like engineering, business, and general health sciences, which may not fully translate to the pharmacy context.^{8,17} While co-op placements are often viewed as supplemental experiences that primarily provide workplace skills, such as communication, teamwork, and project management, this thesis presents empirical evidence that co-op education in pharmacy plays a more important foundational role than previously recognized, particularly in the early professional development and job readiness of students.^{8,17} However, as baseline measures of student skills prior to co-op placements were not available, it cannot be determined whether these skills were developed through co-op experiences or were already present to any extent when students entered their placements. While co-op placements in non-clinical settings, such as policy work or pharmaceutical research, may not directly involve patient care, they equip students with essential skills that are crucial to contemporary pharmacy practice. These skills, such as communication and problem-solving, are often underemphasized in clinical settings, yet are vital to the holistic development of a pharmacist. Despite these advantages, the direct link between co-op experiences and the development of different facets of practice-readiness in pharmacy remains complex and requires further investigation.

7.4 Clinical Rotations and Assessment Tools

Clinical rotations in pharmacy programs have long been regarded as a significant experiential component of pharmacy education.³ These rotations, often directly related to patient care, are considered crucial for assessing practice-readiness, particularly within the context of CBE.⁷ The findings of this thesis confirm the importance of clinical rotations in developing key competencies, such as patient care, medication therapy management, and clinical decision-

making.⁷ However, this thesis also contributes to the growing body of research on the utility of EPAs in assessing student performance. Unlike traditional assessments, such as GPA or clinical evaluations, EPAs may offer a more comprehensive, holistic measure of a student's ability to perform clinical tasks autonomously, an essential component of practice-readiness.

Despite the advantages of EPAs in assessing clinical readiness, their application remains inconsistent across pharmacy programs, and their use in non-clinical settings presents additional complexities. This thesis revealed that many co-op placements involve tasks that do not directly align with clinical EPAs, raising important questions about the validity of using these tools to assess student competencies in non-clinical environments, or clinical environments where EPAs are not always applicable. This finding reflects broader concerns regarding the context-specific limitations of EPAs, particularly when applied outside traditional clinical settings.

7.5 Co-op vs. Rotations: Complementary but Distinct

The juxtaposition of co-op placements and clinical rotations highlights different aspects about their respective contributions to the development of practice-readiness in pharmacy students. Rather than presupposing distinct roles for each placement type, this thesis suggests that both types of placements are essential and serve complementary roles. Co-op placements primarily focus on developing non-clinical skills, such as communication, teamwork, and project management, which are critical in any healthcare setting. In contrast, clinical rotations emphasize the development of clinical competencies, such as patient care and medication management, which are fundamental to pharmacy practice. However, the relative impact of each type of placement on long-term career success in pharmacy practice remains unclear.

A key gap identified in this thesis is the inability to definitively determine which form of experiential learning has a greater impact on long-term career outcomes. This ambiguity arises partly due to the cross-sectional and retrospective design of the research presented in **Chapter 5**, as well as the lack of longitudinal tracking of student outcomes post-graduation in this thesis. This limitation reflects a broader gap in the literature. Research to date has heavily focused on the immediate impact of experiential learning on student performance, such as success on licensing exams or satisfaction with educational experiences. However, few studies have

examined the long-term effects of co-op and clinical placements on career success, job satisfaction, and professional growth.^{26,27} This gap is critical, as understanding the relative contributions of each type of experiential learning could inform curriculum design and better prepare future graduates for professional success.

7.6 Predictive Models and Risk Identification

The development of predictive models to assess student readiness for professional practice is another area where this thesis makes an important contribution. By examining the relationships between co-op evaluations, clinical rotations, course grades, and milestone assessments, this work provides insights into the potential predictors of success in pharmacy education. The findings suggest that certain academic and experiential factors may be associated with indicators of practice-readiness. However, the study also highlights significant limitations in current predictive models, which are often insufficiently robust to predict long-term success or failure.

One key gap in the existing literature is the reliance on academic performance and co-op evaluations as the sole indicators of readiness for practice. While these factors provide useful data, they do not capture the full range of attributes that contribute to success in pharmacy practice, such as interpersonal skills, adaptability, or emotional intelligence. In addition, the predictive models currently in use do not adequately account for the variability introduced by different co-op placements or clinical experiences. The findings of this thesis underscore the need for more comprehensive, multi-dimensional predictive models that incorporate a broader range of data sources such as formative feedback from preceptors, self-assessments, and measures of emotional and social competencies.

7.7 Career Outcomes and Long-Term Impact of Co-op

While anecdotal evidence suggests that co-op placements enhance employability and early career success, few studies have established direct links between co-op performance and long-term professional outcomes, such as career progression, job satisfaction, and the development of professional identity. This thesis makes a key contribution by offering

preliminary insights into how co-op placements may shape students' career trajectories. However, to fully capture the long-term effects, future research should involve longitudinal studies that track graduates over time, exploring how co-op experiences influence job placement, career satisfaction, and ongoing professional growth.

7.8 Strengths, Limitations and Additional Considerations

This thesis presents several notable strengths that contribute significantly to the field of pharmacy education and the understanding of practice-readiness. A key strength lies in its innovative approach to examining the relationship between academic performance, co-op experiences, clinical rotations, and success on entry-to-practice milestones, such as the PEBC Pharmacist QE. By integrating a unique regression model for predicting student performance with both qualitative and quantitative methods, this study offers a comprehensive exploration of these relationships. The mixed-methods design enables a nuanced understanding of the complex factors influencing practice-readiness, addressing areas that quantitative or qualitative data alone cannot fully capture.

The use of multiple cohorts in all chapters of this thesis adds a longitudinal dimension to the research, enhancing the credibility of the findings. This approach reveals trends across different stages of the program, providing deeper insights into practice-readiness predictors such as co-op evaluations and clinical rotation performance. These findings have important implications for developing early intervention strategies for students at risk of underperforming, ultimately improving outcomes and supporting the long-term success of pharmacy students.

This research is strong in examining both co-op placements and clinical rotations in the context of pharmacy education, an area where research is still growing. While most studies focus on clinical rotations, this thesis broadens the scope by considering how co-op education contributes to the development of professional skills, particularly in non-clinical settings. This dual focus offers valuable insights for curriculum development, especially for programs considering co-op integration. Given that the UW PharmD program is one of two North American pharmacy schools with a co-op-based model, the findings provide a unique

contribution to the literature on co-op and entry-to-practice outcomes, potentially helping other institutions reassess their curricula and adopt similar models.

Another key strength of this thesis is the methodological rigor. Professionals from the UW Department of Statistics and Actuarial Science were consulted to ensure that statistical methods adhered to best practices, strengthening the validity of the regression analysis. The qualitative data, integrated into **Chapters 5 and 6**, provide a richer understanding of the complex factors affecting student preparedness for practice. By complementing the quantitative findings, qualitative methods add conceptual depth and uncover subjective insights that enhance data triangulation. These studies also followed established frameworks for trustworthiness, including the Standards for Reporting Qualitative Research (SRQR) and Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines, ensuring transparency and credibility. Ethical principles of confidentiality, dependability, and confirmability were rigorously followed, ensuring the authenticity of findings through triangulation and ongoing informed consent.¹²⁸⁻¹³¹

There are limitations to consider in this thesis. A primary limitation is the research was conducted at a single institution, the University of Waterloo. While the findings are valuable in this specific context, their generalizability may be limited due to differences in institutional resources, program structures, and co-op models. As the UW PharmD program is one of the few that centrally integrates co-op education, the results may not be directly applicable to programs without a similar co-op model. Further research across multiple institutions is needed to validate these findings and extend their applicability.

Another limitation is the voluntary nature of participant involvement in providing comments in the co-op and clinical rotation evaluation tools, limiting the qualitative data available in **Chapters 5 and 6**. It is possible that only those with particularly strong opinions, either positive or negative, chose to provide comments, potentially skewing the data. Future studies could address this limitation by ensuring a more representative sample of supervisors and preceptors from a wider range of placement sites. An additional limitation specific to the EPA component of this thesis is that EPAs assess entrustment decisions over time and are intended to be assessed: (1) longitudinally, (2) across multiple observations, and (3) by multiple assessors. In

contrast, this study was limited to single participant pairs per placement at two assessment time points within the same experiential learning environment. As a result, the findings related to EPAs should be interpreted as exploratory perceptions of feasibility and perceived value rather than as evaluations of EPAs fully implemented within a competency-based assessment system.

The retrospective design of **Chapters 4 and 5** may limit the ability to draw causal conclusions. While associations were found between co-op evaluations, clinical performance, and success on entry-to-practice milestones, these relationships do not imply causality, particularly in the absence of baseline measures of student skills prior to experiential placements. Longitudinal studies tracking students from their first year through to post-graduation would provide a more robust understanding of how early co-op and clinical experiences may influence career outcomes.

Additionally, the data in **Chapters 4 and 5** reflect the UW PharmD curricula before the COVID-19 pandemic, which significantly reshaped didactic and experiential curricula, as the shift to virtual and hybrid co-op placements may have altered student outcomes. It also reshaped pharmacy practice and the delivery of patient care, creating a different environment within which new graduates will practice. While **Chapter 6** did capture post-pandemic data, future research should investigate how these changes have impacted practice-readiness, particularly with respect to clinical competencies and workplace skills.

Finally, there is a limitation to consider with variation in the scope and content of co-op placements. Co-op experiences within the UW PharmD program ranged widely, from direct patient care to pharmaceutical industry, policy, and research placements, and the level of responsibility and involved tasks varied. This variability makes it challenging to assess the true impact of co-op placements on practice-readiness and role of EPAs in co-op, as some placements may have provided more EPA-relevant experiences than others. Future research could examine how specific types of co-op experiences, such as patient-care placements versus administrative or research roles, contribute to different aspects of practice-readiness.

The absence of longitudinal tracking beyond graduation also represents a limitation. While this study identifies early indicators of success until graduation, it does not address long-

term career outcomes such as job placement, professional satisfaction, and career advancement. Given the growing emphasis on WIL to enhance employability, future research should examine the long-term career trajectories of pharmacy graduates who participated in co-op programs to provide a more comprehensive understanding of the lasting impact of co-op placements on career success in pharmacy practice.

7.9 Implications and Future Research Directions

This research has several important implications for pharmacy education, particularly in curriculum design, assessment practices, and student support. First, this research emphasizes the value of integrating both co-op placements and clinical rotations in pharmacy programs. By showcasing the complementary roles of co-op and clinical experiences, this thesis provides crucial insights into how curricula can be structured to prepare students for the diverse demands of pharmacy practice. Given the common challenges students face in transitioning from education to practice, integrating co-op experiences with clinical training can help bridge the gap between theoretical knowledge and real-world application.

In terms of assessment, the study highlights the exploratory potential of CBET frameworks, such as EPAs, to capture student competencies from a different lens across both clinical and non-clinical settings. While EPAs have shown promise in assessing clinical readiness, their application in co-op settings, particularly those not focused on direct patient care, remains underdeveloped. Further refinement is necessary to ensure that non-clinical tasks are adequately evaluated. Integrating EPAs into both co-op and clinical placements could offer a more comprehensive picture of a student's readiness for practice, enabling more targeted feedback and effective interventions.

The study also carries significant implications for student support. Identifying key predictors of underperformance, such as low co-op evaluations, poor clinical performance, and inconsistent academic grades, can inform early interventions for at-risk students. By identifying struggling students early on and providing tailored academic and professional support, pharmacy programs could help prevent poor outcomes on entry-to-practice exams and clinical rotations, ultimately improving student success.

Future research should explore several key areas to deepen our understanding of WIL in pharmacy education. First, a more nuanced definition of practice-readiness is needed. While existing definitions tend to focus primarily on clinical competencies, future studies should incorporate a broader skillset including communication, teamwork, problem-solving, and professional identity, skills that this research has shown are sharpened through co-op placements. Adopting a more holistic framework for practice-readiness could guide curriculum development and refine assessment practices across pharmacy programs.

Second, the long-term impact of co-op education on career outcomes remains an underexplored area. Longitudinal studies tracking the career progression of pharmacy graduates who have participated in co-op programs could offer valuable insights into the sustained impact of WIL on professional development and career satisfaction. Such research could also assess whether co-op placements lead to higher rates of job placement, career advancement, and overall professional fulfillment compared to students who did not participate in co-op education.

Another important research direction is adapting the EPA framework for different clinical settings and non-clinical settings. This study suggests that the current EPA framework, which is predominantly focused on clinical competencies, may not fully capture the range of skills developed in niche clinical environments or non-patient-care co-op placements where such tasks are not applicable. Future research should explore how EPAs can be modified or expanded to assess competencies developed through different clinical and non-clinical experiences. Developing new EPAs or adapting existing ones could make the framework more inclusive of varying practice contexts, providing a more comprehensive assessment of student readiness to practice.

Further research is also needed to improve predictive models for identifying students at risk of underperforming in clinical rotations, co-op placements, or licensure examinations. While this study identified some key predictors of success, more sophisticated approaches such as multi-institutional data sets could enhance the accuracy of these predictions. By leveraging large, diverse datasets, future studies could develop models that account for a wider range of factors influencing practice-readiness.

Finally, the impact of the COVID-19 pandemic on co-op placements and clinical rotations warrants further investigation. The pandemic significantly disrupted traditional learning experiences as well as the healthcare system more broadly. Future research should explore how these changes have influenced the development of practice-readiness among students and whether and how pharmacy programs have adapted their curricula to address current pharmacy practice. This line of inquiry could inform the design of future WIL experiences, ensuring they remain relevant and effective in a post-pandemic world.

7.10 Conclusion

This study contributes to the growing body of literature on experiential learning in pharmacy education by exploring the roles of co-op education and clinical rotations in preparing students for professional practice. The findings highlight the complementary, yet distinct, roles of these two experiential learning models and suggest that both contribute meaningfully to the development of practice-ready pharmacists. The integration of EPAs into the assessment framework shows promise but requires further validation for evaluating professional readiness, but challenges related to context-specific adaptation and assessor consistency remain. Moving forward, there is a critical need for more nuanced, context-specific research to further explore the predictive models of student success, the long-term impact of co-op experiences on career outcomes, and the integration of EPAs across diverse experiential settings. Such studies will be crucial for refining the pathways to developing competent, adaptable pharmacists in an ever-evolving healthcare landscape.

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Appendices

Appendix 4A: University of Waterloo Doctor of Pharmacy Curricular Grid

Admission Requirements		Year One			Year Two			Year Three			Year Four	
		Winter	Spring	Fall	Winter	Spring	Fall	Winter	Spring	Fall	Winter	Spring
BIOC 130/130L Introductory Cell Biology	CHEM 120/120L Physical and Chemical Properties of Matter	PHARM 110 (1.0 CR) Systems Approach to the Study of the Human Body 1 4 LEC Hrs + 1.5 LAB Hrs	PHARM 111 (0.5 CR) Systems Approach to the Study of the Human Body 2 3 LEC Hrs + 1.5 LAB Hrs	PHARM 220 (1.0 CR) Integrated Patient Focused Care 1 5 LEC Hrs + 1 TUT Hr	PHARM 222 (1.0 CR) Integrated Patient Focused Care 3 5 LEC Hrs + 1 TUT Hr	PHARM 320 (1.0 CR) Integrated Patient Focused Care 5 5 LEC Hrs + 1 TUT Hr	PHARM 323 (1.0 CR) Integrated Patient Focused Care 7 5 LEC Hrs + 1 TUT Hr	PHARM 422 (1.0 CR) Integrated Patient Focused Care 9 2 LEC Hrs + 7 TUT Hrs	PHARM 430, 440, or 450 (2.5 CR)			
BIOC 239 Genetics	CHEM 125/125L Chemical Reactions, Equilibria and Kinetics	PHARM 120 (0.25 CR) Introduction to the Profession of Pharmacy 2 LEC Hrs	PHARM 125 (1.0 CR) Pharmaceutics 3 3 LEC Hrs + 3 LAB Hrs	PHARM 221 (1.0 CR) Integrated Patient Focused Care 2 5 LEC Hrs + 1 TUT Hr	PHARM 223 (1.0 CR) Integrated Patient Focused Care 4 5 LEC Hrs + 1 TUT Hr	PHARM 321 (1.0 CR) Integrated Patient Focused Care 6 5 LEC Hrs + 1 TUT Hr	PHARM 324 (1.0 CR) Integrated Patient Focused Care 8 5 LEC Hrs + 1 TUT Hr	PHARM 425 (0.5 CR) Symposium 6 LEC Hrs	Clinical Rotation 1: Primary Care Clinical Rotation 2: Institutional Clinical Rotation 3: Elective			
BIOC 240 Fundamentals of Microbiology	CHEM 237 Biochemistry	PHARM 124 (1.0 CR) Pharmaceutics 1 3 LEC Hrs + 3 LAB Hrs	PHARM 130 (0.50 CR) Professional Practice 2 3 LEC Hrs	PHARM 224 (0.5 CR) Pharmacokinetic Fundamentals 2.5 LEC Hrs + 1.5 TUT Hrs	PHARM 229 (1.0 CR) Professional Practice 4 3 LEC Hrs + 3 LAB Hrs	PHARM 329 (0.25 CR) Professional Practice 5 2 LAB Hrs	PHARM 330 (0.5 CR) Professional Practice 6 2 LEC Hrs + 2 LAB Hrs (flexible)	PHARM 431 (0.13 CR) Seminars in Pharmacy 3 1.5 SEM Hrs	28 CLN Hrs			
MATH 127 Calculus I for the Sciences	CHEM 288/288L Basic Organic Chemistry I	PHARM 126 (0.13 CR) Pharmaceutical Calculations 1 TUT Hr	PHARM 141 (0.5 CR) Introduction to Medicinal Chemistry, Toxicology and Pharmacology 3 LEC Hrs	PHARM 227 (0.25 CR) Health Systems in Society 2 LEC Hrs	PHARM 252 (0.5 CR) Institutional Pharmacy Practice 3 LEC Hrs	PHARM 350 (0.5 CR) Fundamentals of Business Administration and Management 4 LEC Hrs	BUSINESS SELECTIVE (0.25 CR) 2 LEC Hrs	ELECTIVE (0.5 CR) 4.5 LEC Hrs	PHARM 430, PHARM 430, 440, or 450 (2.5 CR)			
MATH 128 Calculus II for the Sciences	CHEM 287/287L Basic Organic Chemistry II	PHARM 127 (0.5 CR) Professional Communication Skills in Pharmacy Practice 3 LEC Hrs	PHARM 151 (0.5 CR) Foundation and Application of Health Informatics 2 LEC Hrs + 1 TUT Hr	PHARM 228 (0.25 CR) Professional Practice 3 2 LAB Hrs	PHARM 290 (0.13 CR) Seminars in Pharmacy 1 1 SEM Hr	PHARM 391 (0.13 CR) Seminars in Pharmacy 2 1 SEM Hr	ELECTIVE (0.5 CR) 3 LEC Hrs	PHARM 430, 440, or 450 (0.5 CR)	Clinical Rotation 1: Primary Care Clinical Rotation 2: Institutional Clinical Rotation 3: Elective			
STAT 202 Statistics	Any ENOL course (0.5 credit) that requires a significant amount of reading, critical thinking, analysis, and writing.	PHARM 129 (0.50 CR) Professional Practice 1 3 LEC Hrs	PHARM 155 (0.25 CR) Introduction to Drug Information Fundamentals 2 LEC Hrs	PHARM 232 (0.25 CR) Medical Microbiology 1 LEC Hr + 1 LAB Hr (flexible)		ELECTIVE (0.5 CR) 3 LEC Hrs	ELECTIVE (0.5 CR) 3 LEC Hrs	Clinical Rotation 1: Primary Care Clinical Rotation 2: Institutional Clinical Rotation 3: Elective	28 CLN Hrs			
Humanities/Social Sciences (2.0 credits)				PDPHRM 1 (0.25 CR) Co-op Fundamentals								
Non-Academic: Pharmacy Admission Information Form, Reference, CASPer, Interview, Fundamentals Skills Assessment, Pharmacy Experience		Contact Hours (per week)			22 Hours (16 LEC, 3 LAB, 2 TUT, 1 SEM)			24 Hours (20 LEC, 2 LAB, 2 TUT)			In Class: 21 Hours (8 weeks) (12.5 LEC, 7 TUT, 1.5 SEM) On Rotation: 28 Hours (24 weeks)	
Requirements and Milestones		Requirement: - Immunizations - CPR/First Aid - Police records check - Registrations with the Ontario College of Pharmacists (OCP)			Milestone: English Language Proficiency Requirement			Requirement: No-Point Assessment			Milestones: Community Service Learning Milestone Final Year Objective Structure Clinical Examination Milestone	
Credit Weight Total Term		0.38	0.26	0.60	0.88	0.38	0.76	0.63				
PharmD Total Cr Weight = 30.6												

Appendix 4B: Abbreviations

Abbreviation	Explanation
APPE	Advanced Pharmacy Practice Experience
Co-op	Cooperative Education
CSL	Community Service Learning
GPA	Grade Point Average
IPFC	Integrated Patient Focused Care
MCQ	Multiple-Choice Question
NAPLEX	North American Pharmacist Licensure Exam
OPPCAT	Ontario Pharmacy Patient Care Assessment
OSCE	Objective Structured Clinical Examination
PCAT	Pharmacy College Admissions Test
PEBC	Pharmacy Examining Board of Canada
PharmD	Doctor of Pharmacy
PP	Professional Practice
QE	Qualifying Exam
UW	University of Waterloo
WIL	Work Integrated Learning

Appendix 4C: Inventory of Skills competencies (co-op work-term evaluation)

Competency	Description
Communication	Demonstrates written communication skills, allowing the reader to logically develop a clear idea of the intended
	Selects communication language which is appropriate for the target audience
	When speaking, uses organized processes; uses listening skills; uses verbal techniques to maximize understanding
Distribution	Addresses concerns related to the validity, clarity, completeness or authenticity of the prescription adhering to applicable regulations and legislation
	Reviews prescriptions for dosage, frequency, appropriateness of therapy. Monitors allergies, intolerances and/or adverse reactions. Reviews any interactions and discusses with supervisor.
	Clarifies missing prescription information, or to obtain further patient information (with physician, nurse, chart or other appropriate means)
	Checks the final product and labelling using systematic approach, including independent double check. Properly utilizes auxiliary labels and patient instruction aids as appropriate.
	Prepares and compounds products using appropriate labelling and expiry dates
	Knowledge of inventory management
	Understands financial aspects of pharmacy; billing processes, 3 rd party payment, ODB codes in community pharmacy or formulary management in hospital pharmacy. If the student is not directly involved, can be a discussion.
Direct Patient Care	Demonstrates empathy and sensitivity when interacting with patients to meet their needs.
	Utilizes interview techniques to ask appropriate questions to delineate patient presentation
	Can provide patient education/counseling on common drugs for new prescriptions. Has ability to perform foundational level of educating patient on proper dose, frequency, method of administration, duration of usage, expected outcomes and storage of medication.
	Using typical pharmacy resources, responds appropriately to common questions. Utilizes available drug info resources.
	Identifies basic, simple drug-related problems with commonly dispensed drugs and common diseases.
	Can assess possible treatment options using an evidence-based approach outlining benefit and risks.
	Monitors outcomes (e.g. calling the patient to follow up on a new prescription or drug-related problem) and adjusts therapy as appropriate.

	Can provide patient education/counseling on over-the-counter products. Has ability to perform foundational level of educating patient on proper dose, frequency, method of administration, duration of usage, expected outcomes and storage of product. Can determine appropriateness for self-care and refers patient to other health care professionals when suitable.
	Can demonstrate the foundational level of the Ontario expanded scope of practice. When within Ontario, performs the foundational level of renewing and adapting prescriptions (alter dose, dosage form, regimen, or route of administration), while keeping the prescriber informed.
Professionalism	Accepts responsibility and accountability for own actions and decisions.
	Demonstrates respect for privacy and confidentiality of the patient.
	Acknowledges, accepts and applies constructive feedback to identify limitations or strengths.
	Utilizes time efficiently, is prepared for patient encounters and demonstrates reliability, dependability and punctuality.
	Maintains professional appearance and follows site policies & procedures.
	Is respectful and cooperative with colleagues and others, and respects patients' and families' rights.

Appendix 4D: Co-op performance evaluation attributes (co-op work term evaluation)

Attribute	Description
Interest in work	The degree to which the student pursues goals with commitment and takes pride in accomplishments.
Ability to learn	The extent to which the student becomes proficient with job duties and work processes.
Quality of work	The ability of the student to set high standards for own personal performance; strive for quality work; put forth extra effort to ensure quality work.
Quantity of work	The volume of work produced by the student, along with his or her speed and consistency of output.
Problem solving	The student's demonstrated ability to analyze problems or procedures, evaluate alternatives, and select the best course of action.
Teamwork	The degree to which the student works well in a team setting.
Dependability	The manner in which the student conducts his or herself in the working environment.
Response to supervision	The manner in which the student responds to direction and constructive criticism.
Reflection	The student's demonstrated ability to learn and adapt from previous experience.
Resourcefulness	The student's demonstrated ability to develop innovative solutions and display flexibility in unique or demanding circumstances.
Ethical behaviour	The extent to which the students' behaviour demonstrates integrity and ethics in work and relationships.
Appreciation of diversity	The degree to which the student shows understanding and sensitivity to needs and differences of others (i.e. ethnicity, religion, language, etc.)
Entrepreneurial orientation	The students demonstrated ability to take informed risks that demonstrate creativity and add value to the company.
Written communication	The extent to which the student demonstrates effective written communication.
Oral communication	The extent to which the student demonstrates effective oral communication.
Interpersonal communication	The extent to which the student effectively listens, conveys, and receives ideas, information, and direction.

Appendix 4E: High correlation coefficients between predictor variables

Pharm 111 (Anatomy and Physiology 2)	Pharm 221 (Integrated Patient Focused Care 2)	Pharm 320 (Integrated Patient Focused Care 5)	Pharm 321 (Integrated Patient Focused Care 6)	Pharm 228 (Professional Practice 3)	Pharm 329 (Professional Practice 5)	Pharm 450 (Clinical Rotation 3)
Pharm 110 (Anatomy and Physiology 1); r=.81	Pharm 220 (Integrated Patient Focused Care 1); r=.73	Pharm 223 (Integrated Patient Focused Care 4); r=.73	Pharm 223 (Integrated Patient Focused Care 4); r=.72	Year 1 OSCE Score; r=.78	Year 3 OSCE Score; r=.8	Rotation 3 OPPCAT; r=.71
Pharm 125 (Pharmaceutics 2); r=.71		Pharm 321 (Integrated Patient Focused Care 6); r=.76	Pharm 320 (Integrated Patient Focused Care 5); r=.76			
Pharm 141 (Medicinal Chemistry, Toxicology and Pharmacology); r=.72		Pharm 323 (Integrated Patient Focused Care 7); r=.73				

Appendix 5A: OPPCAT evaluation criteria (rotation evaluation)

Categories	Description
Patient care	Develops relationships
	Conducts patient assessments
	Identifies drug therapy problems (DTPs)
	Makes clinical decisions
	Implements care plans
	Refers patients
	Provides follow-up and evaluates care
Communication and education	Demonstrates communication skills (verbally and non-verbally)
	Completes documentation
Professionalism	Applies regulations and ethical principles in practice
	Demonstrates an awareness of one's own practice limitations
	Demonstrates professional behaviour
Professional collaboration	Develops and promotes inter-/ intra-professional relationships
	Fulfills professional roles and responsibilities within healthcare team
Practice management	Prioritizes patient care responsibilities to manage patient workload
	Manages drug dispensing
	Demonstrates patient and medication safety

Appendix 5B: Co-op supervisor and rotation preceptor quote examples

Co-op: Professionalism	
Focused on self-improvement and demonstrated a keen willingness to learn	<i>“Has shown a keen interest in learning and has taken many opportunities to improve. Student is very eager to learn and is very self-directed. They can identify their learning needs and work towards fulfilling their objectives.”</i>
Exhibited leadership traits	<i>“Student has taken a leadership role in organizing, initiating and conducting professional services such as medication reviews and immunizations. They have shown a willingness and eagerness to answer patient concerns whether in person or via telephone and has utilized their skillset to provide complete answers that help the patient address their concerns and further enhance their therapeutic goals.”</i>
Adapted well to changes in workflow and circumstances	<i>“Student has continued to demonstrate a very high level of professionalism, integrity, accuracy and work productivity. They work well within our large team and adapts easily to changes in our dynamic environment.”</i>
Established self as a team player	<i>“Student is a team-player in that they offer their advice on how to improve workflow and listens to the suggestions of others in a constructive and positive way, applying them to their daily routine.”</i>
Co-op: Communication with other healthcare providers	
Built strong relationships with healthcare providers through communication	<i>“Student has shown very strong communication skills. They have a high aptitude for working in a multidisciplinary environment. They have excelled at communicating and establishing a professional rapport with the endocrinologists, nurses, dietitians as well as with their pharmacy colleges. Student communications is always clear and efficient and I have received enthusiastic feedback from all of their colleges”.</i> <i>“Written documents are always well-organized and clearly presented.”</i>
Gained confidence, which resulted in effective interactions with healthcare providers	<i>“Student communicates extremely professionally and with great confidence. Their perspective and insights have been readily appreciated by their peers.”</i> <i>“Student has developed excellent communication skills, both verbal and written, during this work term. Whether meeting with patients or other healthcare providers they speaks at an appropriate speed and tone, uses clear terminology and asks questions appropriately to clarify information.”</i>
Exhibited strong presentation skills	<i>“Exhibited strong presentation skills! Student did a lunch and learn presentation for the entire team (endocrinologists, medical staff) on</i>

	<p><i>medical marijuana. The topic was well-received by the staff and the information that was provided was educational for the whole team.”</i></p> <p><i>“Student continued to communicate at a high level both written and verbally with patients and colleagues at the preadmission clinic. In addition to their role in the clinic, student prepared and presented a talk to nurses on medical marijuana. Their visual presentation was well-organized. When giving the talk, student used appropriate volume and pace, and they answered questions thoroughly.”</i></p>
Co-op: Patient Care	
Established self as a strong and trusted health partner through patient-centred communication	<p><i>“Student continued to improve their communication style interacting with patients in a compassionate and competent manner. They engage patients in such a manner to encourage patients to be forthcoming with important health information.”</i></p>
Strong intentional engagement, tailoring language and delivery to the patient	<p><i>“Student always demonstrates a very mature and compassionate ability to listen effectively and to tailor information to all patients' levels of comprehension.”</i></p> <p><i>“Student has become able to tailor their communication to different patients to gather information for medication histories. Student has developed a knack for assessing a patient's ability to comprehend the message and tailors their communication style to ensure that the key points are understood.”</i></p>
Gain in confidence allowed for more focused patient interactions	<p><i>“Student has definitely gained confidence in their communication skillset over the course of their placement. They are able to document in a written format with less editing and review from their supervisor. they is able to select language that is appropriate for the patient. their kind and gentle attitude make them approachable to patients and staff alike.”</i></p> <p><i>“Student has developed excellent written and oral communication skills over this work term. Their communication is always clearly presented, well-organized and utilizes language appropriate for the target audience. When interacting with others, they employ active listening skills and ask for clarification when needed. They have a friendly, soft spoken demeanor which is very comforting to patients.</i></p>
Co-op: Additional observations	
Demonstrated financial competencies	<p><i>“Student is aware of financial aspects and concerns in a community pharmacy setting.”</i></p>
Critical and logical thinking skills, therapeutic knowledge, and ability to solve problems were	<p><i>“Student has quite satisfactorily finished their co-op terms & as usual they also performed extremely well beyond my expectations. Student is extremely focused on patient care and their well-being and goes that extra mile to reach out for them. Student is an excellent team player & has developed perfect skills that rendered</i></p>

<p>well beyond expectations</p>	<p><i>them a valuable resource for us to consult with them as well. Student is a perfect candidate to be in a community pharmacy setting.”</i></p> <p><i>“When discussing a plan that would work completely independently, very good independent work. They show initiative to go beyond the instructions given and seeks clarification when appropriate. Extremely knowledgeable and able to problem solve. When having therapeutic discussions, they was able to apply their knowledge to the patients and extrapolate diagnostic imaging and lab work to the treatment plan.”</i></p> <p><i>“Student has a promising career in hospital pharmacy. In my mind, they are functioning now as a 4th year student and are wise beyond their years. They was able to manage the busiest complement of patients in the hospital while going above and beyond for the patient. as example would be trying to find a family physician for a patient or follow up phone calls for our high risk patients.”</i></p>
<p>Rotations – professionalism</p>	
<p>Focused on self-improvement and demonstrated a keen willingness to learn</p>	<p><i>“Consistent use of appropriate resources to respond to her learning needs & enhance her practice. Good self-directed learning.</i></p> <p><i>“They came prepared to afternoon student debrief meetings. They demonstrated a proficiency in self-directed learning and often came to these sessions having looked up appropriate literature to substantiate their recommendations using patient specific criteria.”</i></p>
<p>Exhibited leadership traits</p>	<p><i>“I saw their leadership skills develop during this placement we had a locum pharmacist work and [student] demonstrated their leadership skill that day by taking control of the dispensary workflow and guiding the staff to their duties.”</i></p> <p><i>“Not afraid to take the lead on anything. The first 1/2 of their rotation they offered leadership and mentorship to 2 U of T 1st year students. The 2nd half they basically ran the pharmacy with little or no help needed.”</i></p>
<p>Strongly contributed to their team</p>	<p><i>“The student had become an integral part of my team and advances the collaboration with other health care professionals we deal with. Student ensures their role is clear within an interprofessional team and works with fellow team members to ensure their expertise as a pharmacist is utilized to the fullest extent when helping clients.”</i></p>
<p>Sought opportunities to elevate practice</p>	<p><i>“Student has positively advanced the profession in this clinic. They have elevated the profession and many staff members would seek them out for consultation.”</i></p> <p><i>“Student developed monitoring tools for patients with congestive heart failure and for patients on anticoagulants which will serve to elevate the level of care we provide to our patients long after they have left us.”</i></p>

Served as an educational resource	<i>“Through the community of practice assignment, student has shown full leadership qualities and has provided the team with valuable resources to launch future programs regarding opioids.”</i>
Perceived as a valuable contributor to their team	<i>“Student definitely has contributed to the overall NICU care team and systems management. Student has been eager to assume more responsibilities in an independent nature related to patient care.”</i>
Rotations – Communication with healthcare providers	
Built strong relationships with healthcare providers through communication	<p><i>“It was evident that the nursing and physician groups appreciated student's insight when dealing with patient challenges. Student was able to work collaboratively with a nurse practitioner at a local family health team.”</i></p> <p><i>“Student has done a great job. A great example is how they handled a physician unwilling to change a prescription that was not to clinical guidelines. This could have resulted in a fractured relationship between her and the prescriber, and instead they worked towards a collaborative solution.”</i></p> <p><i>“Given consistent feedback from other health care providers, student has shown their strong collaborative skills when interacting with other pharmacists or other healthcare professionals.”</i></p>
Gained confidence, which resulted in effective interactions with healthcare providers	<i>“Student has shown significant improvement in assessing their patients. They independently adapt assessments based on needs. This was demonstrated multiple times by being present on the cardiac medical unit and participating in rounds and patient care. Student is more confident and introduces herself to team members. Student is able to develop and maintain relationships with other HCPs by participating in rounds and providing recommendations and follow up. Over time, student has been able to gain trust of nurses, physicians and other pharmacists as well.”</i>
Rotations – Patient care	
Established self as a strong and trusted health partner through patient-centred communication	<p><i>“Advocates for resident well-being. Ensured they spoke to institution’s nurse and other nursing staff. Able to compose recommendations based on the trans disciplinary team's expertise.</i></p> <p><i>“Student was able to communicate effectively and engaged with patients in a friendly and professional manner, which fostered a relationship with them, allowing them to feel comfortable to disclose information about themselves.”</i></p>
Growth in ability to prioritize care across multiple patients with various medication-related issues	<i>“For several complex patients, including lengthy hospital discharges, [student] was independently able to breakdown the patient's profile and identify all DTP's and able to prioritize which issues held the most urgent and significant matters that needed to be addressed.”</i>

<p>Good rapport led to comprehensive assessments</p>	<p><i>“Student entered the placement as a great communicator, and has left with the confidence and ability of an experienced licensed pharmacist. Student is very professional and caring in their approach with both patients and staff in interacting with them, and their use of verbal and non-verbal communication are advanced for any student at this point.”</i></p> <p><i>“[student] has excellent rapport with the patients. Whether it is prescription medication counseling, OTC counseling, or a simple question, they develop a trusting relationship with the patient. This was refreshing to see as it appears to come naturally to them and is a great asset for community practice.”</i></p> <p><i>“I feel student progressed well throughout their rotation and their confidence level grew. Patients and staff trusted their knowledge and decisions.”</i></p>
<p>Strong therapeutic knowledge facilitated trusted recommendations for therapy changes</p>	<p><i>“From early on in this rotation, I have trusted [student] with their judgment with regards to their decision-making. Student typically has recommendations and has ideas they would like me to verify and provides very useful recommendations to other health care professionals.”</i></p> <p><i>“Student took more of a leadership role in the pharmacy as the rotation went on. Student was well-liked and trusted by the whole pharmacy team and became someone the technicians often went to in order to help them solve problems.”</i></p>

Appendix 6A: EPA Assessment Tool (co-op and rotations)

Activity
1. Collect information necessary to identify a patient's medication-related problems and health-related needs.
2. Assess collected information to determine a patient's medication-related problems and health-related needs.
3. Create a care plan in collaboration with the patient, others trusted by the patient, and other health professionals to optimize pharmacologic and nonpharmacologic treatment.
4. Contribute patient specific medication-related expertise as part of an interprofessional care team.
5. Answer medication related questions using scientific literature.
6. Implement a care plan in collaboration with the patient, others trusted by the patient, and other health professionals.
7. Fulfill a medication order.
8. Educate the patient and others trusted by the patient regarding the appropriate use of a medication, device to administer a medication, or self-monitoring test.
9. Monitor and evaluate the safety and effectiveness of a care plan.
10. Report adverse drug events and/or medication errors in accordance with site specific procedures.
11. Deliver medication or health-related education to health professionals or the public.
12. Identify populations at risk for prevalent diseases and preventable adverse medication outcomes.
13. Perform the technical, administrative, and supporting operations of a pharmacy practice site.