

An evaluation of 18 years of use of a progress exam at the Dalhousie College of Pharmacy

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Abstract

Introduction: The purpose of this evaluation was to determine if the seven original objectives of the Progress Exam had been achieved, and to provide recommendations for improvements.

Description of Progress Exam: The Progress Exam was comprised of 100 multiple choice questions based on a blueprint. All students wrote the same exam once yearly at the same time.

Methods: A theory-of-change approach to evaluation was used. Data from 1) a document review; 2) an interview; 3) a survey ; and 4) an eleven year evaluation of Progress Exam results, were collated and analysed.

Evaluation: This evaluation indicated that four of the original seven objectives were achieved (knowledge learned was similar in two different curricula; students' knowledge improved over the duration of the programme; student's knowledge was retained throughout the programme; and, the Progress Exam provided an opportunity to write a comprehensive exam).

Future Work: Review of the results of this evaluation led to recommendations for improvements that are under consideration by the Curriculum Committee.

Keywords: *Evaluation, Comprehensive Exam, Pharmacy, Progress Exam*

Introduction

In 1997, the undergraduate programme at the College of Pharmacy, Dalhousie University in Halifax, Nova Scotia, Canada transitioned from a lecture-based curriculum to a unique outcomes-based integrated hybrid problem-based learning (PBL) curriculum. PBL was selected as the major instructional method because evidence, available at that time, indicated that students of PBL curricula had increased retention of knowledge, were able to integrate basic science concepts with a clinical problem, had enhanced inherent interest in the subject matter and were better self-directed learners (Schmidt 1983; Norman & Schmidt, 1992; Albanese & Mitchell, 1993; Dolmans & Schmidt, 1996). The curriculum was hybrid in that, in addition to the PBL courses, it allowed for the additional components of the critical appraisal series (CAS), skills labs and a practice experience programme (PEP). The hybrid nature of the curriculum also allowed the College to provide more supplemental lectures, and to be flexible in the delivery of some material (for example, in Year 2, pharmacokinetics was offered in a non-PBL lecture-based format).

A comprehensive student assessment plan was developed for the PBL programme that included assessments for each specific curricular component as well as more global assessments. Assessment methods were varied and included methods such as written exams (comprised of multiple choice and short/long answer questions), practice-based exams and PBL/PEP tutors' assessment of students (comprised of tutors/supervisors' written

assessment of students' skills and abilities such as use of reasoning, group skills, communication skills, self-assessment skills, and the ability to research and apply information). Student assessment methods were designed to assess at different levels of Bloom's Taxonomy ranging from knowledge and comprehension to application and analysis (Bloom, 1956). Depending on the length of the PBL course, there was a midterm and/or a final exam. Although each PBL course's content was not explicitly assessed again students were expected to remember the content and apply it in skills lab, CAS, future PBL coursework and PEP rotations. This assessment approach was different from the previous lecture-based curriculum that was comprised primarily of midterm, end-of-term and end-of-year comprehensive cumulative written and practice-based examinations. With the change in curriculum the faculty members of the College wanted to ensure that the knowledge learned in the PBL curriculum was similar to, or better than, that learned in the lecture-based curriculum. Additionally, it was important to know if students retained their content knowledge after completion of a PBL course and that the content knowledge acquisition increased as students progressed through each year of the curriculum.

The College addressed these questions through the development and implementation of a comprehensive multiple choice question (MCQ) Progress Exam. A progress exam is an assessment method that measures knowledge acquisition and retention at specific time points throughout the curriculum (Arnold & Willoughby,

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1990). There are several uses for progress exams suggested in the literature including assessment of individual students, evaluation of the curriculum, prevention of test-directed studying, and emphasis on long-term and functional knowledge (van der Vleuten *et al.*, 1996). Implementation of a progress exam was deemed appropriate to the needs of the College.

In 2014, faculty members of the College were planning the transition of the undergraduate pharmacy programme from a Bachelor of Science in Pharmacy programme to the Entry-to-Practice Doctor of Pharmacy programme. As all aspects of the curriculum, including assessment strategies, were being reviewed, this was an opportune time to conduct a programme evaluation of the College's Progress Exam. Programme evaluation is defined as "the systematic collection of information about the activities, characteristics, and results of programmes to make judgements about the programme, improve, or further develop programme effectiveness, inform decisions about future programming, and/or increase understanding". (Patton, 2008) In this case, the programme being evaluated was the Progress Exam with the main objective of the evaluation to determine if the Progress Exam's seven initial objectives were being achieved. Additionally, the evaluation aimed to provide recommendations for changes/improvements to the Progress Exam to the College's Curriculum Committee.

Description of the Progress Exam

The Progress Exam Working Group has been responsible for oversight of the exam. This Group was comprised of the Chair of the Curriculum Committee (who was also the Associate Director, Undergraduate Education), the Third Year PBL Course Coordinator (who had a pharmacy science background) and a faculty member from pharmacy practice (who was appointed Associate Director of Programme Evaluation in 2010). Due to retirement, the Third Year PBL Course Coordinator was replaced with the Undergraduate Curriculum Administrator. The Undergraduate Curriculum Administrator has managed the entire Progress Exam process from question solicitation to exam construction and administration, maintenance of question banks and dissemination of exam results.

Progress Exam Objectives: Seven objectives for the Progress Exam were identified in 1997 when the exam was first developed and implemented:

- 1) to demonstrate that the knowledge learned by the students in the lecture-based and PBL curricula was equivalent;
- 2) to demonstrate that students were learning in areas of importance to pharmacy;
- 3) to demonstrate to each student how well they were doing overall;
- 4) to demonstrate to each student that they retain knowledge as they progress through the curriculum;
- 5) to demonstrate to students that their knowledge acquisition increases as they progress through the curriculum;
- 6) to provide students an incentive for learning; and
- 7) to provide students with practice writing a comprehensive exam prior to writing the national Pharmacy Examining Board of Canada (PEBC) examination upon graduation from the College.

Multiple-Choice Question Development: Four banks of MCQs have been built over the past 18 years in the areas of: 1) Biomedical Sciences; 2) Pharmaceutical Sciences; 3) Clinical Pharmacy/Pharmacy Practice; and 4) Pharmacy Administration. The question banks were developed with questions from all courses taught during Years 1-3 and the first half of Year 4 of the programme. The second half of Year 4 was spent off campus in clinical placements. Initially, faculty members from each discipline were asked to submit 12 MCQs in their content area each year with half of the questions designed to test at higher levels of Bloom's Taxonomy of learning such as analysis, synthesis and evaluation (Bloom, 1956). Questions were reviewed by the Progress Exam Working Group for content validity (ascertainment that MCQs were relevant, appropriate and representative of the content to be tested) and face validity (ascertainment of the clarity, readability and ease of administration) of the MCQs (Considine *et al.*, 2005).

Over the years, the banks of questions have grown. The banks include new questions that have been submitted and validated by the Progress Exam Working Group but have not yet been used on the Progress Exam. Previously used questions with good question (item) discrimination statistics (see Exam Analysis section below) are also stored and have been reused on a rotating schedule. A review of the question banks identified content areas that had limited number of questions. Therefore, beginning in 2009, the more general request for 12 questions was switched to a "targeted question request". With the "targeted question requests", faculty were asked to provide a specific number of questions in specific areas (e.g. a calculations question; a medicinal chemistry question from a particular course or year of study).

Another more recent change was the request for new questions to be formatted as Type A multiple choice questions. This is a single answer question consisting of 1) the question or stem; and 2) multiple answers including the one correct answer and 3 to 4 incorrect answers (also called distractors). This change was made to more closely match the style of questions being used on the Pharmacy Examining Board of Canada (PEBC) national licensing exams, as one of the objectives of the Progress Exam was to provide students with practice in writing a comprehensive exam prior to writing the PEBC exams.

Exam Construction: Selection of the MCQs to be included on the Progress Exam was based on the Blueprint for the Progress Exam that was initially developed to be representative of the material learned by students at the College and which also represented the major content areas expected to be addressed by pharmacy school curricula to meet standards set by the Canadian Council for Accreditation of Pharmacy Programmes Standards. (CCAPP, 2016) There were four broad curricular areas (Table I) represented on the Progress Exam: Biomedical Sciences; Pharmaceutical Sciences, Clinical Pharmacy/Pharmacy Practice and Pharmacy Administration.

The content of the Blueprint for the Progress Exam was

further refined in 2008-2009 (Table I), by specifying the number of questions from each subcategory of each curricular area (e.g. three questions from the subcategory of “anatomy” from the curricular area of “Biomedical Sciences”). This detail was added to better reflect changes in content areas that had been made in the curriculum since 1997. Additional enhancements to the Blueprint for the Progress Exam included specifying the number of questions that should be examined from each academic year’s content. Detailed records were kept by the Undergraduate Curriculum Administrator to document the specific content or concept covered in each question each year to avoid asking questions on the same topics year after year.

Table I: Blueprint for the Progress Exam 1997-1998 to 2014-2015

Content Areas	1997-1998 to 2007-2008	2008-2009 to present (Year of curriculum from which question taken)*
Biomedical Sciences	20%	15%
Anatomy		3 questions (Year 1)
Physiology		5 questions (Year 1)
Biochemistry		5 questions (Year 1)
Microbiology		2 questions (Year 1)
Pharmaceutical Sciences	30%	33%
Pharmacokinetics/Biopharmaceutics		10 questions (4 from Year 2; 4 from Year 3; 2 from Year 4)
Pharmaceutics		5 questions (4 from Year 2; 1 from Year 3)
Medicinal Chemistry		8 questions (4 from Year 2; 4 from Year 3)
Pharmacology		10 questions (Year 1)
Clinical Pharmacy/Pharmacy Practice	40%	43%
Therapeutics		
<i>Second Year Content</i>		5 questions (1 from dermatology conditions; 1 from eye/ear conditions or nutrition; 2 from respiratory conditions; 1 gastrointestinal conditions)
<i>Third Year Content</i>		7 questions (1 from women’s health topics; 1 or 2 from cardiovascular conditions; 1 from endocrine conditions; 1 or 2 from neurology or psychotherapeutics; 1 from addictions or pain; 0 or 1 from infectious diseases)
<i>Fourth Year Content</i>		3 questions (2 from renal/liver conditions; 1 from cancer)
Laboratory Medicine, Patient Evaluation, Physical Assessment		4 questions (1 from Year 2; 2 from Year 3; 1 from Year 4)
Natural Health Products		4 questions (3 from Year 3; 1 floater**(from Year 2 or 4)
Drug Administration, Patient Counselling		6 questions (2 each from Years 2, 3 and 4)
Drug Information, Literature Review (Critical Appraisal)		8 questions (4 each from Years 2 and 3)
Emergency First Aid/Care		Never used
Health Promotion, Disease Prevention		1 question (floater)
Prescription Processing including Calculation, Compounding		4 questions (1 each from Years 1, 2 and 3; + 1 floater)
OTC		1 question (floater)
Pharmacy Administration	10%	9%
Law/Ethics		3 questions (3 from Year 1)
Various Pharmacy Administration Topics		6 questions (3 from Year 2 and 3 from Year 4)
Questions per Year of Study: Year 1: 29 questions; Year 2: 28 questions; Year 3: 28 questions; Year 4: 11 questions; plus 4 floaters (note: questions based on courses taken on campus - all of Years 1-3 and only half of Year 4)		
*Prior to 2008-2009, detailed records of number of questions from each subcategory and year of study were not recorded.		
**floater = question taken from any content area or year of study		

Each year the Progress Exam was constructed using the Blueprint for the Progress Exam and by reviewing the detailed records to determine which specific topic areas would be tested in that year. New and previously used questions were selected from the question banks that matched the blueprint. If there were not suitable questions in the question banks, “targeted question requests” were emailed to specific faculty members. As a result of this process, selection of questions for the exam was not totally random thus introducing some potential for bias. Once the 100 item Progress Exam had been constructed, the Progress Exam Working Group met to review the draft exam and all new questions received from faculty.

Exam Administration: All students were required to write the Progress Exam to proceed to the next year of the programme (however no mark was recorded on their transcript). The two hour, 100 MCQ, closed-book Progress Exam was scheduled each year on the first Tuesday following the end of the Year 4 PEP rotations. Students were informed of the Progress Exam purpose and date in 1) their Student Orientation Manual that all students received during the first week of classes; and 2) an email reminder sent approximately two weeks before the date of the Progress Exam. The date and location were also posted on the College’s intranet schedule of activities. All students of the College wrote the same Progress Exam at the same time.

Students were provided with the 100 question exam booklet and an MCQ answer bubble sheet on which they recorded their name, year of graduation and student identification number. Students were allowed a pencil and non-programmable calculator only. Upon completion, the Undergraduate Curriculum Administrator sent the bubble sheets to the Dalhousie University department responsible for scanning and producing reports that included student and class scores on the entire exam and subcategories as well as item discrimination statistics.

Exam Analysis: Mean scores for the entire Progress Exam and for the following sections were calculated for each individual, each cohort and all four years combined: Biomedical Sciences, Pharmaceutical Sciences (and the following subcategories: Biopharmaceutics/Pharmacokinetics, Medicinal Chemistry, Pharmaceutics, Pharmacology), Clinical Pharmacy/Pharmacy Practice (and the following subcategories: Natural Health Products, Skills, Critical Appraisal Series, Therapeutics) and Pharmacy Administration.

The item discrimination statistics including item difficulty or p -value (proportion of participants selecting the correct answer) and point-biserial correlation coefficient (statistical comparison of correct and incorrect answers for each question compared to overall test score performance) were completed for each

question for each year of study and for the entire student body. This information was recorded in the question banks with each question. As the number of questions in the banks grew to approximately 1000, and questions were reused, the item discrimination statistics for individual questions were reviewed to aid in question selection. In the literature, the ideal ranges for the p -value (the percentage of people who answered the question correctly) indicating a valid and reliable test question vary from entire range of 0.0 to 1.0, to the narrower range of 0.30 to 0.80 (Considine *et al.*, 2005; Lunz, 2014; Varma, 2014). To ensure that questions were of various levels of difficulty, the Progress Exam Working Group was mindful of the level of item difficulty analysis when choosing questions for the exam. Similarly, in the literature, the ideal point-biserial indicating a valid and reliable test question varies from greater than 0.15; to greater than 0.20; to greater than 0.25 (Considine *et al.*, 2005; Lunz, 2014; Varma, 2014). The Dalhousie University department that provided the score reports and item discrimination statistics recommended a point-biserial of at least 0.15, and thus, this was used for the Progress Exam.

Dissemination of Exam Results: Students were provided electronically with their individual score and their ranking within their own cohort. Students were invited to contact the Undergraduate Curriculum Administrator to review their Progress Exam and obtain a more specific breakdown of how they performed on each section of the Progress Exam. If a student had a GPA of 3.7 (A-) or above for the year and was in the top 50% of their class on the Progress Exam they automatically qualified to be on the Dean’s List which is a designation of recognition by the Dean of a student’s academic success.

Evaluation

Methods

An evaluation framework was developed to guide the theory-of-change evaluation of the Progress Exam. This theory-of-change approach to evaluation describes how a programme (in this case the Progress Exam) contributes to observed results and serves as a way of presenting, organising and completing an evaluation (Treasury Board of Canada Secretariat, 2012). The major steps used in this evaluation framework are described below.

Step 1: Establish Objectives of the Evaluation: The objectives of the evaluation of the Progress Exam were to: 1) assess the extent to which the original seven objectives of the Progress Exam were being achieved; and 2) provide recommendations/feedback to the Curriculum Committee on Progress Exam content/administration/purpose to inform decision making.

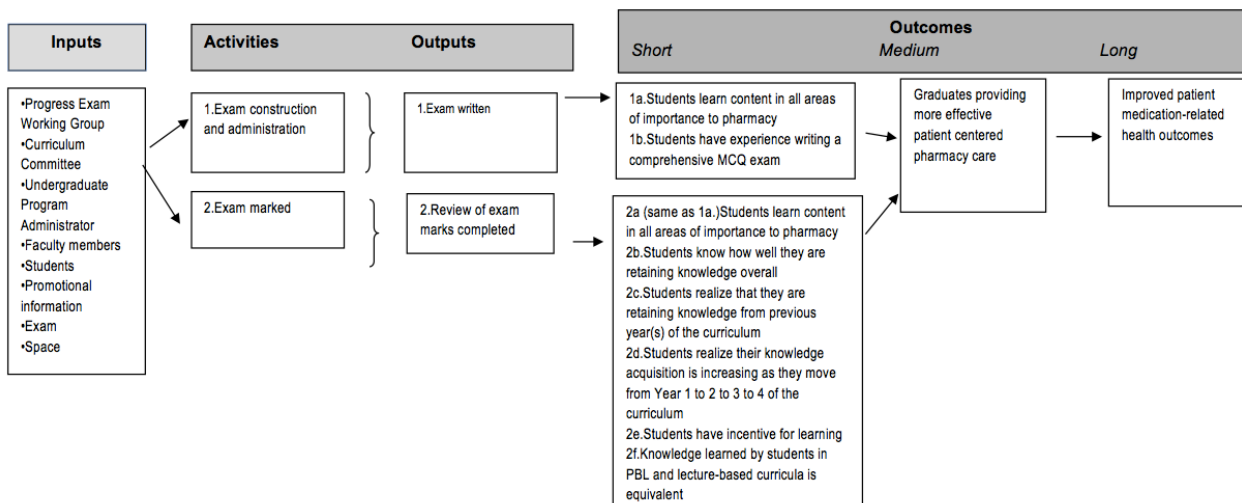
Step 2: Create Programme Profile (Description): A complete written description, also called the programme theory, of the Progress Exam was produced that clearly presented the Progress Exam’s background, rationale, objectives (which in the programme theory are termed “short term outcomes”) and target population. This programme theory was similar to the information presented in this paper in the section titled “Description of Progress Exam”. This text was then summarised in a visual format using a “Logic Model and Theory-of-Change”. (Figure 1) The logic model visually illustrated the various components of the Progress Exam and its activities, outputs and intended outcomes. The theory-of-change depicted how and why the Progress Exam’s activities should result in the Progress Exam’s intended outcomes. This included assumptions (key events/conditions that had to happen for the causal link to occur) and risks (events/conditions/influences that might have prevented the causal link from occurring). Describing the activities and processes needed to achieve the desired outcomes of the Progress Exam via a logic model aided in determining specific evaluation questions and methods for gathering data to address each evaluation question.

Step 3: Develop Evaluation Matrix: An evaluation matrix (a plan for addressing each evaluation objective) was created by first developing key evaluation questions for each evaluation objective. For the first evaluation objective to “assess the extent to which the original seven objectives of the Progress Exam were being achieved” each of the seven Progress Exam objectives were

reframed as a “key evaluation question” (see evaluation questions 1a-11f and 2b in Table II). In order to address the second evaluation objective to “provide recommendations/feedback to the Curriculum Committee on Progress Exam content/administration/purpose to inform decision making” three evaluation questions were developed (see evaluation questions 2a, 2c-2d in Table II). Along with each evaluation question specific indicators, data sources and methods for collecting the data were determined (Table II). As there was no one data source or method that could address all of the key evaluation questions the strategy of “triangulation” was used (Bird *et al.*, 2005; US Department of Health and Human Services Centers for Disease Control and Prevention, 2011). Triangulation is the use of data from several methods that serve to enhance the accuracy of the interpretation. It may involve the use of primary data collection methods and/or the use of existing data sources. Both types were used in this evaluation and are described in Table III.

Step 4: Determine Research Design: The research design was devised to obtain as much information as possible to address each key evaluation question, from the five sources of data described in Table III. The first two data sources were ones that already existed and from which data would be extracted as part of the analysis. The first document was the Blueprint for the Progress Exam which was developed to guide question selection for the Progress Exam. The second data source was the a report of a research study titled “Multiple-Choice Progress

Figure 1: Logic Model and Theory of Change for the Progress Exam



Assumptions/Risks (from Inputs to Activities to Outputs)	Assumptions/Risks (from Outputs to Outcomes)
Inputs to Activities Assumptions: Time available to construct the annual exam Staff available with expertise to manage all aspects of exam Faculty submit good quality exam questions Risks: Exam questions are not representative of curriculum and student learning	Outputs to Short term outcomes Assumptions: By completing the exam, students and the Curriculum Committee will have documentation of how much knowledge the students have retained and applied from their learning. Enough students in the lecture-based and PBL-based curricula will volunteer to participate in the comparison study so that the study can be completed. Risk: Students will not take the exam seriously and results may not be reflective of their true knowledge retention.
Activities to Outputs Assumptions: Students write the exam Marks are tabulated and reviewed by individual students, Progress Exam Working Group, and Curriculum Committee	Short term outcomes to Medium term outcomes Assumption: Graduates who retain and apply knowledge will be more effective at their work. Risks: Knowledge is not used by graduate Medium term outcomes to Long term outcomes Assumption: Graduates who are more effective will be able to identify and solve medication related problems and improve health outcomes Risk: Graduates do not desire to have impact on patient's medication-related health outcomes

Table II: Evaluation matrix for the evaluation of the Progress Exam

EVALUATION QUESTION	INDICATOR	DATA SOURCE	METHODS
EVALUATION OBJECTIVE 1. Assess the extent to which the objectives of the Progress Exam were being achieved.			
1a. To what extent is knowledge learned by students in the PBL and lecture-based curricula equivalent? (Based on an original Progress Exam objective)	Knowledge retained by students in both curricula is not significantly different	Exam Results	Document review: <i>Multiple-Choice Progress Examination: Comparison of Lecture-Based and PBL-Based Curricula: Update 2015 Report</i>
1b. To what extent do students understand how well they are doing overall? (Based on an original Progress Exam objective)	Students agree that they recognise how well they are doing overall	Students	Excerpts from: <i>Doctor of Pharmacy Programme Development: Stakeholder Survey Report</i>
	Review of annual results on Progress Exam indicate student performance	Exam results	Document review: <i>Multiple-Choice Progress Examination: Comparison of Lecture-Based and PBL-Based Curricula: Update 2015 Report</i> <i>Eleven Year Retrospective Review of a Progress Exam Results</i>
1c. To what extent do students realise that they are retaining knowledge from previous year(s) of the curriculum? (Based on an original Progress Exam objective)	Students agree that they are retaining knowledge	Students	Excerpts from: <i>Doctor of Pharmacy Programme Development: Stakeholder Survey Report</i>
	Review of annual results on Progress Exam indicate knowledge retention	Exam results	<i>Eleven Year Retrospective Review of a Progress Exam Results</i>
1d. To what extent do students realise their knowledge acquisition is increasing as they move from Year 1 to 2 to 3 to 4 of the curriculum? (Based on an original Progress Exam objective)	Students agree they are acquiring knowledge	Students	Excerpts from: <i>Doctor of Pharmacy Programme Development: Stakeholder Survey Report</i>
	Review of annual results of Progress Exam demonstrate that exam scores increase as students progress through the curriculum	Exam results	Document review: <i>Multiple-Choice Progress Examination: Comparison of Lecture-Based and PBL-Based Curricula: Update 2015 Report</i> <i>Eleven Year Retrospective Review of a Progress Exam Results</i>
1e. To what extent do students have experience writing a comprehensive MCQ exam? (Based on an original Progress Exam objective)	Alignment of Progress Exam format with PEBC format	Progress Exam Working Group	Interview
	Students agree that the Progress Exam provides opportunity to write comprehensive exam	Students	Excerpts from: <i>Doctor of Pharmacy Programme Development: Stakeholder Survey Report</i>
1f. To what extent do students consider the Progress Exam an incentive for learning? (Based on an original Progress Exam objective)	Students agree that the Progress Exam is an incentive for learning	Students	Excerpts from: <i>Doctor of Pharmacy Programme Development: Stakeholder Survey Report</i>
EVALUATION OBJECTIVE 2. Provide recommendations/ feedback to the Curriculum Committee on Progress Exam content/administration/ purpose to enable decision making (improvement to exam and the role of the Progress Exam in the Doctor of Pharmacy Programme).			
2a. Was the Progress Exam administered as intended every year?	Exam administered annually to all students	Progress Exam Working Group	Interview
2b. To what extent is the content of the Progress Exam addressing content in areas of importance to pharmacy? (Based on an original Progress Exam objective)	Alignment between Progress Exam content and curriculum components as per CCAPP Standards	Exam Blueprint	Document review: the Blueprint for the Progress Exam
		Students	Excerpts from: <i>Doctor of Pharmacy Programme Development: Stakeholder Survey Report</i>
		Progress Exam Working Group	Interview
2c. How can the Progress Exam be improved?	Suggestions for improvement	Progress Exam Working Group	Interview and notes made based on past experience
		Students	Excerpts from: <i>Doctor of Pharmacy Programme Development: Stakeholder Survey Report</i>
2d. Should the Progress Exam be retained in the PharmD programme?	Opinions of former/current students	Students	Excerpts from: <i>Doctor of Pharmacy Programme Development: Stakeholder Survey Report</i>

Table III: Description of data sources used for evaluation of the Progress Exam

Data Source	Description of Data Source (Including Objective, Methods and Summary of Results (as appropriate))
Existing Data Sources	
1) "Blueprint for the Progress Exam" (Table I)	<ul style="list-style-type: none"> •represents material learned by students at the College and the major content areas expected to be addressed by pharmacy school curricula to meet standards set by the Canadian Council for Accreditation of Pharmacy Programmes Standards. •four broad curricular areas: Biomedical Sciences; Pharmaceutical Sciences, Clinical Pharmacy/Pharmacy Practice and Pharmacy Administration. •more details were added to the blueprint in 2008-2009: 1) the number of questions from each subcategory of each curricular area (e.g. 3 questions from the subcategory of "anatomy" from the curricular area of "Biomedical Sciences"; and 2) the number of questions to be examined from each academic years' content.
2) A report of a research study (conducted from 1998 to 2001) titled "Multiple-Choice Progress Examination: Comparison of Lecture-Based and PBL-Based Curricula: Update 2015" (hereafter referred to as "comparison study") that had been prepared for the Curriculum Committee	<ul style="list-style-type: none"> •Objective: to determine if the knowledge learned by students in the PBL (Classes of 2001 to 2004) and lecture-based curricula (Classes of 1998 to 2000) is equivalent. •Methods: Students in both curricula were invited to participate in the study which meant that the results of their Progress Exam would be compared. Data was collected from 1998 to 2001. The SPSS 9.0 for Windows was used to conduct analyses of variance to examine the mean standardised scores comparing overall results for each year of study. •Summary of results: <ul style="list-style-type: none"> -Number of Participants (out of 90 students in each class): approximately 12 from Class of 1998; 14 from Class of 1999; 12 from Class of 2000; 56 from Class of 2001; 47 from Class of 2002; 55 from Class of 2003 and 60 from Class of 2004. -Students standardised scores improved as they progressed through each year of the curriculum. Some differences in scores were identified between the PBL and lecture-based cohorts but they were not consistent. Differences were also found between PBL cohorts. •Ethics approval for the comparison study was received by the Faculty of Health Professions Ethics Committee.
Data Collected for this Evaluation	
1) Eleven Year Retrospective Review of a Progress Exam Results (Classes of 2005 to 2015) (hereafter referred to as "review of exam results")	<ul style="list-style-type: none"> •Objective: to gather data to aid in determination if the following objectives of the Progress Exam were met: demonstration of students' 1) overall performance; 2) progressive knowledge acquisition and application as they moved through the curriculum; and 3) retention of knowledge learned in previous years of the curriculum. •Methods: A descriptive analysis was completed using the mean raw scores on the entire exam and the 4 major categories for each of the 4 years of the curriculum for the classes of 2005 through 2015. •Summary of Results: results were displayed graphically in a report that was prepared for the College's Curriculum Committee. These graphs were reviewed for trends which suggested that students' knowledge was retained and did improve over the 4 years of the curriculum; however not consistently in all content areas. Students received their scores each year so had the opportunity to understand how well they were performing overall. •Ethics approval was not needed as this project was considered programme evaluation and not research.
2) Doctor of Pharmacy Programme Development: Stakeholder Survey (hereafter referred to as "survey")	<ul style="list-style-type: none"> •Objective: to gather information to help inform the curricular design and content of the new Doctor of Pharmacy programme; a section of this survey obtained feedback on the Progress Exam. •Methods: <ul style="list-style-type: none"> -Questions for the survey were requested from the Curriculum Committee and a draft copy of the survey was prepared. With regards to the Progress Exam former and current students were asked 1) their level of agreement (strongly disagree, disagree, neutral, agree, strongly agree) that the objectives of the progress exam were met; 2) their motivation (aside from it being mandatory) for writing the exam; and 3) if the exam should be retained in the new curriculum. -Survey pilot tested by the Curriculum Committee (seven faculty members, two alumni, two student members) and final revisions made. -On February 23, 2015, 1509 stakeholders (all faculty and students at the College and pharmacists from the three provinces served by the College) were emailed an invitation to participate in the on-line survey. Two reminders were emailed automatically on March 6th and March 17th to those who had not completed the survey. •Summary of Results: <ul style="list-style-type: none"> -The overall response rate was 33.5%. Of the respondents who answer the question about "current position" 4.4% were faculty; 32.7% were students; 17.8% were employers/supervisors/managers; 38.6% were practicing pharmacists and 6.5% other. -The survey software (Opinio) generated a report which included descriptive statistics; a more in depth statistical analysis using SPSS was provided by a consultant. Written comments were examined for common themes. -Results were incorporated into a report that was prepared for the Curriculum Committee. •Ethics approval was not needed as this project was considered programme evaluation and not research.
3) Interviews (hereafter referred to as "interview")	<ul style="list-style-type: none"> •Objective: to gather feedback from members of the Progress Exam Working Group about the exam administration; what worked well and suggestions for improvement •Methods: An interview guide was developed that identified the objectives being assessed, the script, and the 5 interview questions (1) was the exam administered as intended each year?; 2) did the exam give students experience writing a comprehensive multiple choice exam?; 3) did the progress exam test content in areas important to pharmacy?; 4) do you think the format of the exam questions is similar to that used by the Pharmacy Examining Board of Canada?; 5) do you have any other comments about the progress exam?). The interviewer recorded responses by taking notes. Data was analysed by the interviewer by identifying themes. •Summary of Results: Two members of the Progress Exam Working Group, including the Undergraduate Curriculum Administrator, were interviewed. The responses to the interviews were collated into a final report. •Ethics approval was not needed as this project was considered programme evaluation and not research.

Examination: Comparison of Lecture-Based and PBL-Based Curricula: Update 2015” (hereafter referred to as “comparison study”) that had been prepared for the College of Pharmacy Curriculum Committee. The next three data sources were to specifically collect data for this evaluation. The first was the “Eleven Year Retrospective Review of the Progress Exam Results (Classes of 2005 to 2015)” (hereafter referred to as “review of exam results”) which analysed the results of exam results for 11 years and collated all of the results into a report for the College’s Curriculum Committee. The second was the “Doctor of Pharmacy Programme Development: Stakeholder Survey” (hereafter referred to as “survey”) which gathered data from past and current students about their opinions of the Progress Exam. This data was collated into a report which was presented to the Progress Exam Working Group. The last data source was interviews with two members of the Progress Exam Working Group (hereafter referred to as “interview”). Each of these data sources and a brief overview of the objective, methods, and summary of results (as appropriate) are described in Table III.

Step 5: Collect and Analyse Data: Data was collected using each of the data sources described in Table III. The approach for analysing the data from these data sources for the purposes of this evaluation was threefold. First, data from the three documents/data sources (the Blueprint for the Progress Exam, the comparison study and the interview) were extracted. To aid in this extraction, a data extraction form was developed which outlined each key evaluation question and the names of the three documents being reviewed. One author then went through each document and extracted any data that addressed the key evaluation question. Secondly, for the data that had been specifically collected and analysed for this evaluation, results that could be used to address each key evaluation question were identified. Thirdly, to address each key evaluation question, the results identified above as addressing each key evaluation question from all sources were integrated in written text (as summarised below in the “Results” section).

There were limitations to the above analysis. As this was an evaluation and not a research project, limited time and resources were allocated which reduced the rigour with which this type of evaluation might have been completed. Using the triangulation strategy was intended to offset some of the above limitations and help to enhance the accuracy of the interpretations. Another limitation of this process was that only one person completed the data extraction as the other two authors were both participants in the interview. Therefore some data that could have addressed the key evaluation questions may have been missed. However, both of the other authors did review and provide feedback on the data analysis.

Step 6: Synthesise and Communicate Findings: The major results of this evaluation, with discussion, are summarised below according to the two major evaluation

objectives and the key evaluation questions. All three authors contributed to the synthesis of the findings.

Results

Evaluation Objective 1. Assess the extent to which the seven original objectives of the Progress Exam were being achieved.

Key Evaluation Question 1a: To what extent is knowledge learned by students in the PBL and lecture-based curricula equivalent?

Based on the results of the “comparison study”, some differences were found in Progress Exam scores between the lecture-based and PBL cohorts; however, these differences were not consistent. For example, in the fourth year of their respective programmes, the PBL Class of 2001 scored significantly lower ($p=0.001$) than the lecture-based Class of 1998 but not the lecture-based Classes of 1999 and 2000. In the third year of their respective programmes, the two PBL Classes of 2001 and 2002 scored significantly lower ($p=0.027$ and 0.036 respectively) than the lecture-based Class of 2000 but not significantly different than the lecture-based Class of 1999. Some differences in scores were also identified between PBL cohorts. For example, in the first year of their respective programmes, the PBL Class of 2003 ($p=0.001$) and 2004 ($p<0.001$) scored lower than the PBL Classes of 2001 and 2002. There were many limitations (e.g., it was mandatory for PBL students to write the exam while students from the lecture-based curriculum volunteered to participate; relatively few students from the lecture-based curriculum volunteered to participate in the study; the difficulty of the Progress Exam was not consistent from year to year) to the study which may have contributed to these results. Overall, it did not appear that the differences in results among the lecture-based and PBL cohorts could be attributed solely to the type of curriculum.

Key Evaluation Question 1b: To what extent do students understand how well they are doing overall?

The results of the “comparison study” completed in 2001, and the “review of exam results” completed in 2015, provided the Progress Exam Working Group and the Curriculum Committee with two opportunities to review students’ performance over several years. Students could track their individual Progress Exam results annually to ascertain how well they were doing overall. However, feedback from former/current students via the Doctor of Pharmacy Programme Development: Stakeholder Survey was not so clear. While 88/208 (42%) of respondents “agreed” that the Progress Exam was successful in demonstrating how well they were doing overall, 83/208 (40%) “disagreed”. Respondent comments suggesting that students do not take the Progress Exam seriously, that they wrote the Progress Exam only because it was mandatory, that it was a waste of time, and that it was

administered at a bad time of the year, may help explain the former/current students' rating on this objective.

Key Evaluation Question 1c: To what extent do students realise that they are retaining knowledge from previous year(s) of the curriculum?

Data from the "review of exam results" showed that mean raw scores on Year 1 content of the progress exam stayed between 50 to 60% as the students from the Classes of 2015 and 2016 moved through the first three years of the curriculum. Similarly mean raw scores on Year 2 content stayed between 60 and 70% for the Classes of 2015 and 2016 as they moved from Year 2 to Year 3 of the curriculum. This type of analysis was started in 2015 so data is limited; however it may suggest that students were retaining knowledge as they progressed through the curriculum. More years of data are needed to confirm this. Students could track their individual Progress Exam results each year to determine how much information they were retaining. Feedback from former/current students via the Doctor of Pharmacy Programme Development: Stakeholder Survey indicated that 130/208 (62.5%) "agreed" that the Progress Exam did demonstrate retention of knowledge learned in previous years of the curriculum.

Key Evaluation Question 1d: To what extent do students realise their knowledge acquisition is increasing as they move from Year 1 to 2 to 3 to 4 of the curriculum?

Data from the "comparison study" demonstrated that mean standardised scores on the Progress Exam increased as the class moved through the curriculum. For example, the first PBL cohort (Class of 2001) had a mean score of 61/100 in Year 1, 68/100 in Year 2, 73/100 in Year 3 and 75/100 in Year 4. As the study only ran for 4 years, this is the only PBL cohort for which this data is available. However, this trend was also observed in the "review of exam results", where, for the Classes of 2005 to 2015, mean raw scores for each class in each year of the curriculum improved as each class moved through the four years of the programme. When the mean scores for each Class were averaged, a similar pattern emerged. Mean scores for the 11 classes (2005 to 2015) in Year 1 were 41/100 (range 38-46); 50/100 (range of 46-53) in Year 2; 57/100 (range 54-60) in Year 3; and 57/100 (range 54-64) in Year 4. As with the PBL Class of 2001, mean scores from Year 3 to Year 4 did not increase as much as in previous years. This could be that new material was taught in only the first half of Year 4 while the remainder of Year 4 was spent in practice rotations. Students could track their individual Progress Exam results each year to determine if their marks were improving as they progressed through each year of the curriculum. Feedback from former/current students via the Doctor of Pharmacy Programme Development: Stakeholder Survey indicated that 132/208 (63.5%) "agreed" that the Progress Exam did demonstrate that their overall knowledge increased as they moved through the curriculum.

Key Evaluation Question 1e: To what extent do students have experience writing a comprehensive MCQ exam?

The "interview" with members of the Progress Exam Working Group confirmed that the College has provided students an opportunity to write a comprehensive exam since the PBL programme began in 1997. The Doctor of Pharmacy Programme Development: Stakeholder Survey feedback from former/current students indicated 160/208 (76.9%) "agreed" that the Progress Exam has provided practice writing a comprehensive exam.

Key Evaluation Question 1f: To what extent do students consider the Progress Exam an incentive for learning?

Overall, the Doctor of Pharmacy Programme Development: Stakeholder Survey feedback from former/current students of the College indicated that 129/206 (62.6%) "disagreed" that the Progress Exam provided an incentive for learning. Respondent comments, suggesting that they saw no benefit or value to the Progress Exam, that there was no mark so there was no incentive to do well, that they had no hope of making Dean's List or getting scholarship, may help explain the rating on this objective.

Evaluation Objective 2. Provide recommendations/feedback to the Curriculum Committee on Progress Exam content/administration/purpose to enable decision making (improvement to Progress Exam and the role of the Progress Exam in the Doctor of Pharmacy Programme).

Key Evaluation Question 2a: Was the Progress Exam administered as intended every year?

The "interview" with members of the Progress Exam Working Group confirmed that the Progress Exam was administered every April for the last 18 years as originally intended.

Key Evaluation Question 2b: To what extent is the content of the Progress Exam addressing content in areas of importance to pharmacy?

The "interview" with members of the Progress Exam Working Group and a review of the Blueprint for the Progress Exam confirmed that the Progress Exam was based on essential content areas as specified by CCAPP. The Doctor of Pharmacy Programme Development: Stakeholder Survey feedback from former/current students of the College indicated that only 108/208 (51.9%) "agreed" that the Progress Exam demonstrated that they were learning in all the areas of importance to pharmacy. Respondent comments suggesting that the Progress Exam was not reflective of what is needed for practice, and that the exam was not reflective of what is on PEBCs, may help explain the rating on this objective.

Table IV: Recommendations for changes/improvements to the Progress Exam

Recommendations for Change if the Progress Exam is Continued in its Current Format for Similar Purposes
<p>Exam Objectives and Purpose:</p> <ul style="list-style-type: none"> • Consider assigning a value to the Progress Exam (e.g. a grade or requirement of passing the Progress Exam before progressing to next year of the programme). This would address the concern that the Progress Exam is not taken seriously by the students. However, it should be noted that former/current students did not think the Progress Exam should be high stakes. • Objectives should be updated and clearly articulated to students so that their expectations of the Progress Exam are appropriate and they are aware of the intent and value of the Progress Exam. • Re-evaluate the role of the Progress Exam in determining those achieving Dean's List. This would address the concern that some students do not think the results of this Progress Exam are a true reflection of their knowledge. It would also address the concern that only students who think they have a chance of making the Dean's List based on their GPA make an attempt to perform well on the Progress Exam. • Faculty members should understand the Progress Exam's purposes/objectives so that they have a better appreciation of the importance of the requests for new questions and question reviews.
<p>Exam Content:</p> <ul style="list-style-type: none"> • Review and update blueprint such that the major content areas being tested are aligned with changes made to the curriculum since 2009, changes to CCAPP Standards and the blueprint for the PEBC Evaluating Exam. • Change weighting of content areas to better reflect the percentage of the curriculum each content area represents. • Change the number of test questions from each year of the pharmacy programme so that it is more reflective of what is taught in each year of the curriculum. • Improve reliability (test results are reproducible) of the exam. • Improve consistency of level of exam difficulty from year to year.
<p>Timing of Exam</p> <ul style="list-style-type: none"> • Re-consider timing of administration of the Progress Exam to minimise concerns expressed by former/current students about conflict of current Exam with other activities.
<p>Exam Results</p> <ul style="list-style-type: none"> • Provide students with Progress Exam section scores (Biomedical Sciences, Pharmaceutical Sciences, Clinical Pharmacy/Pharmacy Practice, and Pharmacy Administration) so that students can determine their success in each section compared to the mean for their class. • Provide students with Progress Exam results for questions they would be expected to have learned (e.g. In Year 1, provide results from Year 1 questions; in Year 2 provide results from Year 1 and Year 2 questions, etc). • Provide Progress Exam results in a timelier manner (for example if the Progress Exam is administered at the end of the academic year, consider providing results twice: once as soon as marks are available and then again when students return to classes in September so that they can make an appointment to review exam results). • Provide an annual report to the Curriculum Committee and the Student Promotions Committee of Progress Exam results to allow for continuous monitoring and improvement.
<p>Additional Recommendations for Change to the Progress Exam if it is Changed to "High Stakes"</p> <ul style="list-style-type: none"> • Questions should be pretested and item difficulty and discrimination analysis completed before they are used on the Progress Exam (e.g. can pretest on a Progress Exam; results not used in calculating score). • The Progress Exam should be constructed in such a way that it is reliable, and has a similar level of difficulty from year to year.
<p>Role of the Progress Exam in the Doctor of Pharmacy Programme</p> <ul style="list-style-type: none"> • Additional feedback should be considered when determining the role of the Progress Exam in the Doctor of Pharmacy programme as only feedback from the former/current students of the College who have written the Progress Exam has been collected; the majority of these students "did not think/were unsure" if the Progress Exam should be retained in the Doctor of Pharmacy programme.

Key Evaluation Question 2c: How can the Progress Exam be improved?

The "interview" with members of the Progress Exam Working Group and "survey" feedback from former/current students provided several suggestions for improving the Progress Exam. Common themes were: exploring options for assigning academic value to the Progress Exam; re-examining content areas; including more incentives; and including a review of the Progress Exam.

Key Evaluation Question 2d: Should the Progress Exam be retained in the Doctor of Pharmacy programme?

Doctor of Pharmacy Programme Development: Stakeholder Survey feedback from the former/current students of the College indicated the respondents were not in favour (94/206 (45.6%)) of or were unsure (48/206 (23.3%)) if the Progress Exam, in its current format should be retained in the Doctor of Pharmacy programme. The majority of respondents, 151/206 (73.3%) did not think it should be high stakes. Respondents in favour of retaining the Progress Exam made suggestions for changes; these have been incorporated in Table IV.

Strategies for communicating the above findings and recommendations in Table IV are currently underway. A full report of the findings was prepared and submitted to the Progress Exam Working Group and the Curriculum Committee of the Dalhousie College of Pharmacy. Both groups are reviewing the results and the recommendations for potential improvements and to inform decision making regarding the current and future use of the Progress Exam.

Future Work

Summary of Evaluation Results: The Progress Exam has been used internationally by health professional programmes, such as pharmacy and medicine, for many years (Blake *et al.*, 1996; van der Vleuten, 1996; McHarg *et al.*, 2005; Szilagyi, 2008; Swanson *et al.*, 2010; Waskiewicz, 2011; Schuwirth & van der Vleuten, 2012). The College of Pharmacy at Dalhousie University is the only faculty of pharmacy in Canada that currently utilises such an assessment method. Implementing and administering a comprehensive progress exam has been resource intensive requiring psychometric expertise, faculty commitment, student buy-in to the value of the exam, administration personnel and time, and other resources. Therefore, the evaluation of the value of the Progress Exam at this time of transition at the College was crucial to aid in decision making concerning assessment strategies.

This evaluation provided evidence that the Progress Exam did successfully achieve four of the original seven objectives of the Progress Exam. Specifically, the

“comparison study” provided evidence that the knowledge learned by the students in the lecture-based and PBL curricula did not appear to be different. Evaluation results demonstrated that students’ knowledge not only improved but was retained as they progress through the four years of the curriculum. Additionally, the Progress Exam provided students with an opportunity to write a comprehensive MCQ exam prior to the PEBCs. One objective was not achieved as former/current students did not agree that the Progress Exam was an incentive for learning. Evidence was not so clear with regard to two objectives. Although the Blueprint for the Progress Exam was based on essential content areas as specified by CCAPP only 52% of former/current students agreed that the Progress Exam was addressing areas of importance to pharmacy. Forty percent of former/current students agreed while 42% disagreed that the Progress Exam helped them to understand how well they were doing overall despite being provided Progress Exam results annually and having the opportunity to review their individual exam. Results from the other three evaluation questions have provided data and feedback to the Progress Exam Working Group and the Curriculum Committee to use for making informed decisions about the Progress Exam.

Self-Reflection: Concurrently with the formal evaluation of the Progress Exam, the Progress Exam Working Group reflected on what they considered had been successful and unsuccessful over the years. Most notably, the Progress Exam Working Group has been successful for the past 18 years in developing, implementing and administering the only Progress Exam in a pharmacy faculty in Canada. The Progress Exam Working Group also successfully completed a comprehensive evaluation of the Progress Exam using a theory-of-change approach utilising several data collection methods. The primary reason for these successes has been the commitment of the Progress Exam Working Group members and others who have been recognised in the acknowledgement section for their contributions.

When reflecting on what has worked successfully with regards to questions for the Progress Exam, the building of organised questions banks with item discrimination statistics has had a huge positive impact. Previously used questions with good item discrimination statistics can now be reused. The addition of the Undergraduate Curriculum Administrator to the Progress Exam Working Group has resulted in enhanced record keeping of annual Progress Exam content and question statistics. The constant monitoring of the question banks and Progress Exam content by the Undergraduate Curriculum Administrator resulted in the change to solicit “targeted” instead of general questions from faculty. The “targeted question requests” and the recycling of previously used questions had the positive outcome of lessening workload for faculty who had previously been asked to submit 12 questions per year. This approach has also resulted in more systematic coverage of the curricular content.

Finally, a more detailed Blueprint for the Progress Exam was developed and has been expanded as a result of the Undergraduate Curriculum Administrator’s contributions.

The Progress Exam Working Group noted that as time passed from the original implementation of the PBL curriculum, students did not seem to clearly understand the Progress Exam’s value (despite annual reminders). This may be reflected in some of the feedback received from former/current students. The Progress Exam Working Group has also identified some changes it would like to make to the Progress Exam such as improving exam reliability (test results are reproducible) and having a consistent level of exam difficulty from year to year. Limited resources have precluded these changes to date.

Modifications Planned: The results of this evaluation and the recommendations for change to the Progress Exam have been presented to, and are under consideration by, the Curriculum Committee. The first set of recommendations (Table IV) was based on the Progress Exam being retained in the programme and being used for purposes similar to those from its first implementation 1997. These were further subdivided into recommendations specific to the “exam objective and purpose”, “exam content”, “timing of exam” and “exam results”. The second set of recommendations pertain to a situation where the Progress Exam is high stakes. Lastly, recommendations regarding the use of the Progress Exam in the Doctor of Pharmacy Programme are included. Once the Curriculum Committee has completed its deliberations, changes to the Progress Exam, as per their instructions, will be made.

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