

Using Formative Content Analysis to Improve Learning Outcomes in a Pharmaceutical Care Course

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ABSTRACT. The Introduction to Pharmaceutical Care course sequence exposes first-year professional phase (P1) pharmacy students to basic practical knowledge including pharmaceutical calculations, prescription abbreviations and interpretation, and drug information resources. The objective of this study was to compare baseline student knowledge to post-instruction knowledge in content areas of a pharmaceutical care course. A pre- and post-instruction assessment was completed by each student. The results of this evaluation showed that 91% of students would have failed the course prior to instruction, while 88% passed the post-instruction assessment. The effect of previous work experience was also evaluated. The results of this evaluation may be used to improve learning outcomes and potentially focus course content. *[Article copies available for a fee from The Haworth Document Delivery Service: 1-800-HAWORTH. E-mail address: <docdelivery@haworthpress.com> Website: <<http://www.HaworthPress.com>> © 2005 by The Haworth Press, Inc. All rights reserved.]*

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INTRODUCTION

Curriculum development is an ongoing, dynamic process of revision and refinement. Assessment may be done at various points within a curriculum (1). Assessment can be done longitudinally to ensure student integration of learning across multiple courses. At the course level, assessment will indicate if the particular course is meeting its stated objectives. Ideally, individual courses within a curriculum evolve and improve with time based upon careful review and modification. While summative assessment solely and formally evaluates performance at the end of an instructional unit, formative assessment seeks to facilitate learning through continual collection of information to guide instructional revision (2).

Formative assessment is considered a tool for evaluation of student progress through periodic feedback and modification based upon that feedback (3). Formative assessment allows students to discover deficiencies they may have in their basic knowledge and understanding before they are tested at a summative level (4). These formative assessments are not threatening as they do not carry a grade penalty and can indicate areas where additional study is needed. This technique can also be applied more broadly to course development. Here, content and delivery are revised based upon regular assessments that guide subsequent course offerings. While “feedback” traditionally leads to changes of immediate benefit to the learners from whom it is acquired, formative assessment may also be used to benefit future groups of students (2, 5). Assessment is considered to be formative when the information gathered is used to improve and adapt instruction to meet the needs of learners (6).

The Introduction to Pharmaceutical Care 1 (RX350) course has undergone several recent revisions. Both content and format have been altered frequently in an effort to simultaneously meet student needs and provide the necessary knowledge base for success in the professional phase of the pharmacy program. One challenge has been to fit all of the desired content into the limited allotment of class time. It is currently unknown if the majority of students already possess a significant proportion of the knowledge and skills that are introduced in RX350.

The primary objective of this study was to compare baseline student knowledge to post-instruction student knowledge in the major content areas of the RX350 course. Using a pre-test and post-test assessment, we predicted that instruction over the course of the semester will improve objective scores by an average of 25%. A secondary objective

was to determine the effect of prior work experience on baseline student knowledge. It was anticipated that students with substantial work experience will perform better than students with little to no pharmacy practice experience. Student age and previous degree status were also to be considered.

METHODOLOGY

The present study was a prospective, pre- and post-test study design which was interventional as opposed to observational. The intervention was instruction and the study sought to determine the effect of instruction on student performance on an objective examination, as well as the effect of experience or previous degree on performance without instruction.

Students in the first professional year (P1) of Butler University College of Pharmacy and Health Sciences' RX350 course were enrolled in the study. Participating subjects completed a 48-item multiple-choice format objective examination composed of questions designed directly from course objectives listed in the syllabus (Appendix A). Fifteen sample questions are provided in Appendix B with a reference to the learning objective being assessed. The defined content areas and corresponding number of questions on the examination were: package inserts (4), tertiary drug information references (6), electronic drug information sources (4), apothecary symbols and conversions (6), basic dose calculations (6), dose calculations within a prescription (3), prescription interpretation (4), dose forms and dose form counseling (4), general pharmacy practice (wellness, top 200 drugs) (11). The pre-instruction exam was delivered during regular class time at the beginning of the fall semester 2002 prior to the initiation of instruction. After completion of the pre-instruction examination, regular classroom instruction began.

For the collection of demographic data, students completed an information sheet during the pre-instruction examination. Age (in years) and gender of each student was recorded. Students were asked to note if they had a previous college degree, and if so, at what level and for what major. Students checked if they were a transfer student to Butler for their P1 year. Current GPA range was also checked (2-2.4, 2.5-2.9, 3-3.4, or 3.5-4.0). Previous pharmacy work history was collected as to whether or not the student had worked in a pharmacy, what type of setting (hospital, retail, or specified other), and length of that experience (less than 1 year, 1-3 years, or over 3 years).

Subjects were subsequently given an exam identical to the pre-instruction examination upon completion of the semester-long course, but prior to the final examination. Students were given the post-instruction test during regular class time. Exams were pencil/paper format and were electronically graded. Students were allowed one hour to complete both the pre-instruction test and the post-instruction test. Scores were temporarily linked to student university identification numbers for analysis per the study design outlined in the informed consent. All students were provided with an informed consent form that was explained verbally before students were asked to participate. Students then signed and dated the form if desired. Approval was obtained from the Butler University Institutional Review Board (IRB). The pre- and post-test scores did not affect student grades in the course.

Demographic information was tabulated and interpreted using descriptive statistics (percentages). Pre-instruction and post-instruction scores were analyzed with a paired t-test (alpha 0.05) using the NCSS computer program. Statistical analysis of pre-instruction scores and demographic data (previous experience or college degree) was also performed using NCSS. The sample size ($n = 105$) was sufficient to detect a 25% difference in examination scores with greater than 80% power.

RESULTS

One hundred and five students were enrolled in RX 350 during the fall 2002 semester and all participated in this study. Seventy percent of students were female and 21 percent held previous college degrees (Figure 1). Twenty seven percent (27%) of the students transferred to Butler for their P1 year. Most students were either 20 or 21 years of age (Figure 2). A surprisingly substantial proportion of students, however, were 22 years of age or older (23%).

Seventy-seven percent ($n = 81$) of all students had previous pharmacy work experience while twenty-four students (23%) had no previous pharmacy work experience. Of those having work experience, 79% had retail experience, with the rest consisting of either a combination of retail and hospital, hospital alone, or long-term care facility experience (Table 1). Among those students possessing previous pharmacy-related work experience, 17% had greater than three years practice before starting the RX350 course. Most students who had practice experience however, had between one and three years of pharmacy experience (63%). The remainder (20%) had less than one year of pharmacy work experience.

FIGURE 1. Student Demographics

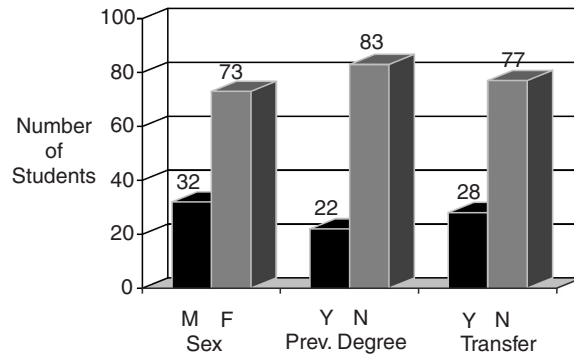
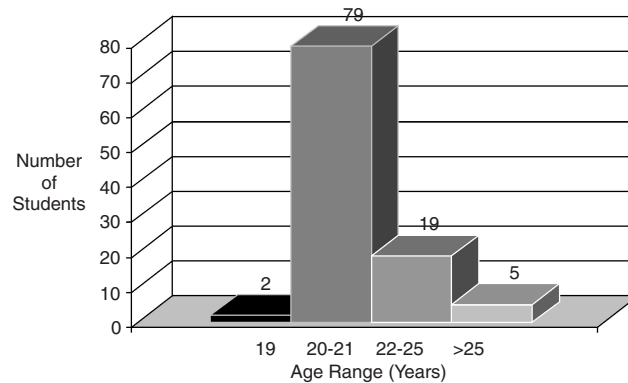


FIGURE 2. Student Age Distribution



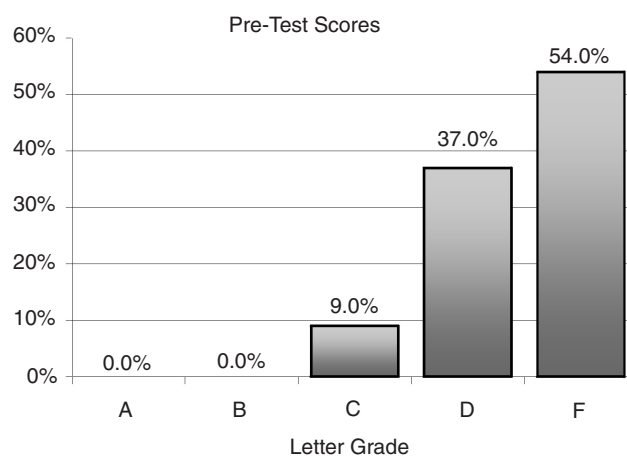
Given the extent of students' previous work experience, the pre-instruction examination results were surprisingly low. Forty-eight total points were possible, with the mean score (\pm S.D.) for the pre-test being 57% (\pm 10%). The median score was 58% with a high score of 75% and a low score of 27%. The usual grade distribution for RX 350 would be as follows: A = 90% or better, B = 80%-89%, C = 70%-79%. Below 70% has traditionally been a failing grade. The letter grade distribution of the pre-instruction examination was skewed, with no students obtaining a grade of A or B and only 9% of students passing with a C. Ninety-one percent of the students failed the pre-examination (Figure 3).

Post-instruction scores were dramatically improved relative to pre-instruction exam scores. Of 48 total points possible, the mean

TABLE 1. Previous Pharmacy Work Experience

| | Number of Students (n = 81) | % |
|--------------------------------------|--------------------------------|-----|
| <u>Experience Setting</u> | | |
| Retail Pharmacy | 64 | 79% |
| Retail + Hospital Pharmacy | 10 | 12% |
| Hospital Pharmacy | 4 | 5% |
| Long Term Care Pharmacy | 3 | 4% |
| <u>Length of Pharmacy Experience</u> | | |
| Greater than 3 years | 14 | 17% |
| 1 to 3 years | 51 | 63% |
| Less than 1 year | 16 | 20% |

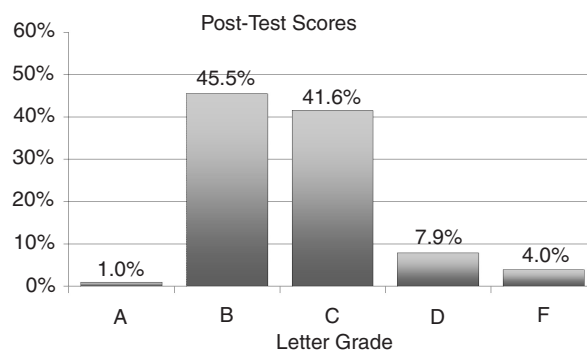
FIGURE 3. Pre-Instruction Examination Results



score (\pm S.D) for the post-test was 78% (\pm 8%) The median score was 80% with a high score of 94% and a low score of 40%. Eighty-eight percent (88%) of the students passed the post-test with an A, B, or C grade, while 12% of students would have received an F. This demonstrated an impressive “left shift” (Figure 4).

A statistically significant difference was demonstrated between scores. The pre-instruction scores differed from the post-instruction scores by

FIGURE 4. Post-Instruction Examination Results



at least 25% overall ($P < 0.0001$, $t_{\text{paired}} = 56.2$). Greater than one year of pharmacy-specific work experience also positively affected pre-instruction test scores ($p = 0.006$). Students with more than one year of experience performed better on the pre-instruction exam relative to students with less than one year or no experience. The possession of a previous college degree had no statistically significant effect on pre-instruction exam scores ($p = 0.64$).

We considered the course content areas in which students improved most (from pre-instruction to post-instruction) to be those defined as items in which a greater than 50% increase in the proportion of students provided correct responses (i.e., half the class). The content areas, thus defined, where improvement was most noteworthy were those corresponding to the following: package inserts, tertiary and electronic information resources, apothecary symbols, basic math calculations, prescription interpretation, dosage forms, and wellness.

Areas that require more emphasis during the semester were defined as those items in which fewer than 70% of students achieved correct responses on the pre-instruction examination. The content portions linked to the published objectives that require more emphasis based upon this definition included: dosage calculations within a prescription, apothecary conversions, dose form counseling, and the top 200 drugs.

DISCUSSION

In its current structure, RX350, Introduction to Pharmaceutical Care 1, appears to be meeting the needs of Butler University's P1 students. Because a statistically significant difference between pre-instruction

scores and post-instruction scores was detected, the current allotment of instructional time is very efficient at meeting course objectives. Given this, the data indicate that small but specific changes may be made to the current curriculum that may help save time and provide more room for expanded instruction in areas that require more attention.

From the pre-instruction exam results, there are a few content areas that may be considered for removal because greater than 90% of students got test items correct on the pre-instruction examination. Students scored well on areas of basic math calculations (exponential notations, metric system) and the concept of plagiarism. These areas may be addressed in self-study or group work modules in the future. In these modules, students would be responsible for mastery of the information, but in-class instructional time would not be allotted. The potential also exists to use the assessment function with Butler's Blackboard® software system for individual student testing. This system has the capability of on-line quizzing and testing, which can be done outside of the confines of classroom instruction. Students can take an on-line assessment and get immediate feedback as to areas of strengths and weaknesses. Blackboard® also allows students to have access to educational resources posted by the instructor, easy e-mail communications, and discussion boards and chat rooms. In RX 350, students may also access their grades on Blackboard®.

It was anticipated, with the large number of students having previous work experience, that other content areas would have scored high on the pre-instruction examination as well. The areas expected to also show high initial scores were general pharmacy practice, prescription interpretation, dosage forms and dose form counseling, and dose calculations within a prescription. This was not found to be the case. It is possible that since the results of this pre-instruction examination did not count towards a grade, the students did not take the examination seriously. This may also be a problem with the post-instruction examination. It is administered at the end of the semester, immediately prior to the start of finals. Again, students may not complete the examination to the best of their ability. Conversely, the post test may reflect actual content learned during the semester, not just memorized for a single examination.

There are a number of additional limitations to this study. The results reflect only one class of students during one academic semester. Each class of students has its own unique make-up, so we would envision the need to do a pre-instruction examination yearly. These results can not be applied to other institutions, with different class compositions and course requirements. Additionally, some students do not perform well

on standardized examinations such as these, no matter what the setting or content of the examination.

With the removal of class time spent on the previously mentioned content areas of basic math calculations and plagiarism, extra class time could be spent reinforcing those content areas that showed need for enhanced instruction. Such areas that might benefit from in-class repetition and expansion are prescription dose calculations, apothecary conversions, dose form counseling, and the top 200 drugs. Improvement in these content areas will serve Butler pharmacy students well in future professional classes, particularly the pharmaceuticals and therapeutics sequences.

CONCLUSION

While the current RX350 Introduction to Pharmaceutical Care 1 course is currently an outstanding preface to subsequent professional courses, based upon the results of this study, an annual entrance survey regarding previous pharmacy-specific work experience might be an efficient method of preemptively tailoring course content to meet the needs of individual group of students. By gathering work experience data in advance of instruction, an instructor might know ahead of time which basic content areas can be left to self-study, leaving more time for calculations and problem solving. From this analysis, content areas that would ideally be suited for self-study are basic math calculations and plagiarism.

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APPENDIX A. Course Learning Objectives (number of questions on assessment)

1. Communicate effectively with health care professionals and patients
 - a. Answer a specific pharmaceutical question through group work or individually, employing the systematic approach to answering questions used in class (4 questions)
 - b. Counsel and educate patients and caregivers regarding their medications and various dosage forms (4 questions)
2. Drug Information
 - a. Learn and demonstrate the ability to search tertiary references and databases to answer a pharmaceutical question (8 questions)
 - b. Define and recognize plagiarism (1 question)
 - c. Demonstrate the ability to use the correct referencing format (1 question)
3. Prescription processing
 - a. Evaluate the acceptability of prescription order transmission and legitimacy of sources (1 question)
 - b. Clarify, add, and/or correct prescription order information when necessary (3 questions)
 - c. Interpret prescription or medication order using approved medical and pharmaceutical abbreviations (4 questions)
 - d. For the Top 200 medications, be able to identify their trade and generic names, therapeutic category, primary indication, and dosage forms (2 questions)
4. Calculations
 - a. Demonstrate the ability to perform basic pharmaceutical calculations (6 questions)
 - b. Convert between the different measuring systems used in pharmacy (6 questions)
5. Professionalism
 - a. Explain the concept of pharmaceutical care (5 questions)
 - b. Perform and behave in an ethical manner
 - c. Explain the importance of patient confidentiality (1 question)
 - d. Understand the meaning and responsibility of personal wellness (2 questions)

APPENDIX B. Sample Pre- and Post-Test Questions

1. *When providing prescription drug counseling, the PPCP format (communications)*
 - a. *verifies patient understanding*
 - b. *uses open ended questions*
 - c. *includes the three prime questions and a final verification*
 - d. *all of the above*
2. *In the following prescription, interpret the instructions to the patient: (prescription processing)*

Rx Ibuprofen 600mg tab
Disp. QS x 30d
sig. i po TID pc prn OA

- a. *Take one tablet by mouth three times a day as needed for oral analgesia.*
 - b. *Take one tablet by mouth three times a day after meals as needed for osteoarthritis.*
 - c. *Take one tablet two times a day before meals as needed for otic analgesia.*
 - d. *Take one tablet three times a day before meals as directed for osteoarthritis.*
3. *If a physician prescribes cephalexin suspension, 250 mg q.i.d. for 10 days, how many milliliters of suspension containing 250 mg cephalexin per 5 ml should be dispensed? (calculations)*
 - a. *100 ml*
 - b. *200 ml*
 - c. *300 ml*
 - d. *500 ml*
4. *How many kilograms does a 194 pound patient weigh? (calculations)*
 - a. *426.8 kg.*
 - b. *2.34 kg.*
 - c. *97 kg.*
 - d. *88.2 kg.*
5. *One fluid ounce contains approximately: (calculations)*
 - a. *30 ml*
 - b. *15 ml*
 - c. *10 ml*
 - d. *5 ml*

6. *An emulsion is a: (dosage form communications)*
 - a. *dispersion of a solid in a liquid in which the solid particles are not soluble.*
 - b. *clear, homogeneous mixture of particles dissolved in liquid.*
 - c. *mixture of liquids in which one is dispersed in another as droplets.*
 - d. *semisolid polymer infiltrated with liquid.*
7. *Which of the following electronic medical resources offers full-text copies of primary literature journal articles? (drug information)*
 - a. *Clinical Pharmacology 2000*
 - b. *Iowa Drug Information*
 - c. *Micromedex*
 - d. *Lexi-Comp Clinical Reference Library*
8. *Which of the following tertiary references has potential manufacturer bias? (drug information)*
 - a. *PDR*
 - b. *AHFS*
 - c. *USP-DI*
 - d. *Facts and Comparisons*
9. *The holistic model of health includes which facets? (professionalism)*
 - a. *social*
 - b. *emotional*
 - c. *physical*
 - d. *all of the above*
 - e. *none of the above*
10. *The concept of “wellness” differs from that of “health” by its emphasis on: (professionalism)*
 - a. *individual responsibility*
 - b. *well-being*
 - c. *psychological fitness*
 - d. *social and occupational influences*
11. *In which of the following tertiary references may drug pricing (e.g., AWP) information be found? (drug information)*
 - a. *The Merck Index*
 - b. *The Merck Manual*
 - c. *Facts and Comparisons*
 - d. *The Red Book*
12. *Which of the following is true? (prescription processing)*
 - a. *Legend drugs are only available with a prescription*
 - b. *Schedule CII prescriptions can be refilled one time only*
 - c. *Schedule CV drugs have no accepted medical use in the United States*
 - d. *Indiana prescriptions are valid until all refills are used*