Development of a Comprehensive Assessment Examination for Baccalaureate Pharmacy Students

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ABSTRACT. The College of Pharmacy at Wayne State University recently implemented a revised competency-based baccalaureate pharmacy curriculum. All graduation competencies are cross-referenced to a specific course within the curriculum. The objectives of this project were to: 1. develop a valid and reliable comprehensive assessment examination, and 2. determine if student learning on experiential training can be measured by an improvement in student performance on the comprehensive examination. A total of 311 questions submitted by faculty underwent external review for content validity. Exam questions meeting an acceptable level of content validity, $n = 286$, were field tested on 196 students from six colleges of pharmacy. Questions meeting an appropriate difficulty level, 30-80%, and an appropriate discrimination level, point biserial correlation coefficient of ≥ 0.2 for the correct response were included in the final question pool. A total of 183 questions met the above criteria. These questions were used to create a 100-point comprehensive assessment examination which is given to Wayne State University students just prior to experiential training. A second version of the examination was created in 1997 from the excess questions and administered to students after completion of experiential training. Student performance significantly improved after clerkship. The comprehensive examination will serve multiple purposes at Wayne State University including student self-assessment, a measure of student learning both across the curriculum

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INTRODUCTION

The College of Pharmacy at Wayne State University recently implemented a revised competency-based baccalaureate pharmacy curriculum. The restructuring of our curriculum led to the development of several modular courses within the fourth professional year. These 1- to 4-credit courses combine physiology, pathophysiology, pharmacology, medicinal chemistry, pharmacokinetics, and clinical management of a body system into one course. The College faculty were interested in obtaining a measurement of student learning in the new curriculum other than traditional examination performance in individual courses. Five years earlier, the College had undertaken the development of a valid and reliable comprehensive student examination (1). Since the new curriculum was significantly different in terms of structure and content, the old comprehensive examination was no longer applicable. The objectives of this project were to: 1. describe the process for the development of a comprehensive assessment examination for baccalaureate pharmacy students which contains several improvements from the development of the first examination, and 2. determine if learning during experiential training can be measured by an improvement in comprehensive examination performance.

METHODOLOGY

College of Pharmacy faculty and adjunct faculty submitted multiple-choice examination questions for courses in which they held major teaching responsibilities. Faculty were asked to submit questions which test the higher levels of Bloom's taxonomy. All faculty received two resource references on how to write appropriate multiple-choice exam questions (2,3). Approximately 10 questions per credit hour were submitted from key courses in the first two professional years of the curriculum. All questions submitted had only

one correct answer with three distractors. Questions were reviewed by two external reviewers. Reviewers were recognized leaders in pharmacy and were usually experts in the area being reviewed. A majority of reviewers were members of the Editorial Board of the *Annals of Pharmacotherapy.* Reviewers assessed questions for content validity, *i.e.,* the degree to which the test includes a representative sample of all tasks that could have been included (4). In order to evaluate this, reviewers were provided with written competency statements for the Wayne State University's undergraduate baccalaureate program in pharmacy. The competency statements for courses in which questions were written were highlighted for each reviewer. Reviewers ranked content validity on a scale of 1 to 3 as follows:

1. The question is very representative of the knowledge or skills required in the indicated area.
2. The question is possibly representative of the knowledge or skills required in the indicated area.
3. The question is not representative of the knowledge or skills required in the indicated area.

Questions with content validity rankings of 1 or 2 or a combination thereof were included in the initial testing tool. External reviewers were also asked to indicate the level of Bloom's taxonomy the questions tested, *i.e.,* knowledge, comprehension, application, analysis, synthesis, or evaluation. Reviewers were provided with a definition of each level. If the expert reviewers did not agree on the level of Bloom's taxonomy, an educational consultant evaluated the question.

Questions meeting the desired content validity rankings were used to construct two examinations for field testing. Each examination contained a representative number of questions from each course within the curriculum. Exam A contained 144 questions and Exam B contained 142 questions. All colleges of pharmacy which offered an undergraduate baccalaureate program in pharmacy were surveyed regarding their interest in participating in the field testing. Participating schools were mailed an the appropriate number of examinations (evenly divided between Exam A and Exam B), instructions for the test administrator, and Scantron forms. Students

who participated in the field test were completing their fourth professional year. The examination was administered at all schools in April or May of 1996. Students were given three hours to complete the examination. After completion of the examination Scantron forms were returned and the examination was shredded. Students did not receive incentives other than a summary of their performance for participating in this project.

The results of the field testing were used to perform an item analysis, including the level of difficulty and discrimination of each question. The item analysis was performed by the Wayne State University Testing and Evaluation Center. Questions with a difficulty level of 30-80% and a discrimination level of a point biserial correlation coefficient of ≥ 0.2 for the correct response were included in the final question bank. The final question bank was used to develop a 100-point final testing instrument administered to Wayne State University students prior to their experiential training beginning in the fall semester of 1996. In the winter semester of 1997, a second version of the comprehensive examination was developed. This examination was administered to students after completion of either their hospital pharmacy clerkship or their hospital-community pharmacy clerkship rotations. Differences in student performance pre- and postclerkship were assessed using a t-test. The level of significance was set at $p < .05$.

RESULTS

A total of 311 questions submitted by the faculty underwent external review. Of these, 286 met the desired level of content validity. The external reviewers agreed on the level of Bloom's taxonomy for 138 of the 286 questions. The educational consultant decided the level of Bloom's taxonomy for the remaining questions. The percentage of questions falling into each level was as follows: knowledge: 52.1%, comprehension: 14.0%, application: 18.2%, analysis: 5.9%, synthesis: 8.0%, and evaluation: 1.4%.

A total of 192 students from six colleges of pharmacy participated in the field testing of questions. Overall results are shown in Table 1. Performance on questions corresponding to individual courses within the curriculum is shown in Table 2. A total of 183

TABLE 1. Overall Field Test Results.

	Exam A	Exam B
Number of examination questions	144	142
Number of students taking examination	96	100
Mean number correct ± standard deviation	66.0 ± 11.0	64.7 ± 15.1
Range of scores	42-93	0-95
Standard error of mean	5.27	5.21
Hoyt reliability estimate	0.77	0.88

questions met the desired level of difficulty and discrimination, while 66 questions were dropped. The most common reason for dropping a question was low difficulty level.

The final question pool contained 183 questions with a difficulty level 30-80% and a point biserial correlation coefficient of ≥ 0.2 for the correct response. This question pool was used to construct the final testing instrument of 100 questions. The final instrument contained three overall areas of the curriculum: disease management, patient management, and basic science. The disease management section contained questions involving pathophysiology, physiology, and clinical management. The patient management component included questions on over-the-counter medications, law, calculations, and patient education. Pharmacokinetics, pharmacology, and medicinal chemistry were covered in the basic science section. The final examination contained 55 questions on disease management, 30 questions on basic science, and 15 questions on patient management. The allocation of questions to each section was representative of the amount of curricular time devoted to each area. The excess allotment of questions ($n = 83$) allowed for a variation in examination questions which are included in the testing instrument each year. This examination was administered to Wayne State University students just prior to the initiation of experiential training starting in the fall semester of 1996. A summary of examination performance by Wayne State University students is shown in Table 3. The comparison of student performance pre- and postclerkship in 1997 is provided in Table 4. Student performance significantly improved after clerkship in all areas with the exception of basic sciences.

TABLE 2. Field Test Results by Individual Curricular Course.

Examination Area	Questions/Subtest (Exam A)	Mean Number of Correct Responses
Inflammation	4	1.83
Patient Education	7	3.77
Endocrinology/ Respiratory	9	4.10
Over-the-Counter Drugs	5	3.21
Autonomic Pharmacology	5	1.41
Calculations	4	2.18
Clinical Toxicology	4	2.19
Psychiatry/ Drug Abuse	6	3.23
Infectious Disease	16	6.04
Oncology	8	3.70
Gastroenterology	9	4.08
Cardiology	19	7.61
Renal/ Fluids	5	2.56
Law	7	4.15
Special Populations	9	4.89
Drug Action	10	3.95
Drug Disposition	10	4.16
Neurology	7	2.90

*Total number of exam questions from Exam A and Exam B meeting difficulty and discrimination levels.

Questions/Subtest (Exam B)	Mean Number of Correct Responses	Total Number of Questions (A&B)*
5	1.72	7
8	3.74	8
8	3.55	9
5	3.04	8
5	1.12	4
4	2.92	5
5	2.56	5
6	3.32	8
15	7.47	19
7	3.48	11
9	4.86	11
19	8.34	24
5	2.16	8
6	2.99	9
9	4.18	15
10	3.16	10
10	3.44	12
6	2.67	10

TABLE 3. Wayne State University Student Performance on Final Testing Instrument.

Summary Item	Fall 1996	Winter 1997
Number of examination questions	100	100
Number of students taking examination	36	37
Mean number correct ± standard deviation	60.4 ± 8.8	59.9 ± 7.5
Range of scores	46-74	43-71

TABLE 4. Student Performance on Comprehensive Examination Pre- and Postclerkship.

	Preclerkship	Postclerkship*
Number of students taking examination	35	35
Mean number correct ± sd** for all 100 questions	59.7 ± 7.5	67.5 ± 6.8 ($p = 0.0001$)
Range of scores for all 100 questions	43-71	51-78
Mean number correct ± sd for disease management ($n = 55$)	32.5 ± 4.36	37.2 ± 4.2 ($p = 0.0001$)
Mean number correct ± sd for basic science ($n = 30$)	18.0 ± 2.9	19.1 ± 2.6 ($p = 0.056$)
Mean number correct ± sd for patient management ($n = 15$)	9.2 ± 2.1	11.0 ± 1.9 ($p = 0.0001$)

*Postclerkship examination is identical in construct to the preclerkship examination with 70% of the examination questions being new and 30% being repeat questions from the preclerkship examination.

**sd indicates standard deviation.

DISCUSSION

This paper describes the process used at Wayne State University for the development of a valid and reliable comprehensive examination. Although a similar project was undertaken five years earlier,

improvements in the process have been made. First, faculty members received written resource materials on the do's and don'ts of writing of multiple-choice examination questions. Second, external reviewers were hired to evaluate the content validity of the potential examination questions. These reviewers, whenever possible, were experts in the area being tested. In addition, the reviewers were provided with a list of competencies for the course in which the examination questions originated. This ensured that the question was appropriate for the course objectives and that the reviewer was knowledgeable in the area of the examination questions. In the comprehensive examination developed earlier at Wayne State University, internal reviewers were used. The reviewers may or may not have been knowledgeable of the content area of the questions, and course objectives or competencies were not assessed. In the newly developed comprehensive examination, questions were assessed for the level of Bloom's taxonomy. A certain level was not required for inclusion into the final testing instrument. This information will be shared with faculty; however, the majority of questions submitted were at the lower levels of Bloom's taxonomy—knowledge and comprehension.

The overall performance on the field testing was similar to our experience five years earlier. There was no significant difference in the student performance on Exam A versus Exam B. Once the final testing instrument was constructed, students at Wayne State University performed better than the students participating in the field test. This is expected for several reasons: 1. our students are familiar with the style of questions our faculty write, 2. only the best questions from the field test were included in the final testing instrument, and 3. our students may have had more incentive to perform well since scores above 70% were worth bonus points in an orientation course for experiential training.

In an effort to measure student learning during experiential training, 35 students in the class of 1997 completed a preclerkship and postclerkship examination. Student performance significantly improved after clerkship. Performance in the disease management section improved by 12.0% ($p = 0.0001$), in the basic science section by 3.7% ($p = 0.056$), in the patient management section by 8.5% ($p = 0.0001$), and on the overall examination by 7.8% ($p =$

0.0001). As students did not study for this examination, their improved performance likely serves as a measure of learning during experiential training. Due to limitations in the structure of the fifth professional year, some students had completed 6 weeks of experiential training (6 weeks in hospital pharmacy) before the postclerkship examination while others had completed 11 weeks (6 weeks in hospital pharmacy and 5 weeks in community pharmacy). Students improved least in the area of basic science which is probably the examination component which is least focused upon during experiential training.

This paper outlines the process for developing a valid and reliable comprehensive examination for baccalaureate pharmacy students. The development of the examination was a very time-consuming process. At our College, this process is repeated every five years to ensure the content reflects curricular change and new knowledge. Administering a comprehensive examination pre- and postclerkship provides an objective method of measuring student learning during experiential training. Since accreditation agencies are requiring programs to develop measures of learning and document outcomes, the development of a comprehensive examination will serve multiple purposes at Wayne State University: 1. student self-assessment, 2. a measure of student learning across the curriculum, and 3. a measure of learning during experiential training.

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