

Pre- and Post-Rotation Assessment of Pharmacy Student Learning

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ABSTRACT. This study aims to examine the value and viability of implementation and maintenance of an assessment tool for clinical rotations. Specifically, the objective of the study was to determine if student post-test scores were significantly and consistently higher at the conclusion of the rotation as compared with pre-test scores on an ambulatory care knowledge assessment. Pharmacy practice faculty members developed learning objectives and multiple-choice questions (MCQ) for commonly encountered topics in disease state management. Questions were

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pilot tested, stratified by difficulty level and randomized into assessments for the testing phase. Students ($n = 53$) completed ten MCQ in each of three topic areas for a total of thirty questions on the first day of rotation. Scores were reviewed with students. Thirty questions of similar difficulty level were administered during the last week of a five-week rotation. Overall improvements from pre-test to post-test scores were statistically significant ($p < 0.001$). Statistically significant improvements from pre-tests to post-tests were noted in the areas of diabetes, dyslipidemia, and anticoagulation ($p < 0.001$). Administering a standardized assessment tool provides quantitative and qualitative benefits to students and preceptors including (1) identification of deficiencies in pharmacotherapy knowledge base early in the rotation, (2) ability for students to tailor self-learning activities to address those deficiencies during the rotation, and (3) provision of additional evidence to the students supporting their accomplishments on rotation. [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

The Accreditation Council for Pharmacy Education Draft Professional Degree Program Accreditation Standards and Guidelines states that schools and colleges of pharmacy must design and implement a system to assess student achievement of stated educational outcomes and utilize the information gathered through this process to continuously improve the didactic and experiential curricula (1). Experiential education is an essential component of pharmacy curricula, however, the variability of experiential sites, the variety of day-to-day student experiences, and the educational training of preceptors at each site may lead to assessment discrepancies in student achievement of global educational outcomes.

The fundamental goal for students completing experiential education rotations is to provide direct patient care in an actual patient care setting (2). More specifically, universal objectives of the hands-on experience include increased knowledge and skill development for practice. Experiential learning follows a continuum beginning with knowledge, competence, performance and finally, action (3). Each level of the continuum

depends on the previous level. For example, the learner must “know” the content to “know how” to apply it to the clinical situation. To adequately assess student performance in the clinical setting, the evaluator may use a variety of tools including direct observation, simulated experiences, verbal examinations, discussion, or written examinations (2,4). The literature suggests that preceptors take a global approach to assessment by evaluating a student’s baseline practical knowledge, communication skills, attitude and the ability to integrate these at the level expected of a pharmacist (4-6). Despite a general understanding that a student’s baseline knowledge may affect his or her success on rotation, there are limited examples in the current literature of pre- and post-tests for assessment of experiential education.

One study of pharmacy students used paired baseline and end rotation written examinations to determine the potential role in the student learning and evaluation process (7). Eighty-six students from an inpatient care rotation participated by completing twenty short answer questions matched to the educational objectives of the rotation. Overall, the investigator identified pre-tests as a useful measure to assess baseline competencies and individualize instruction. Another study examined the acquisition of knowledge by medical students during a clinical rotation (8). An optional pre-test and mandatory post-test was administered to the students using a question bank of multiple-choice questions (MCQ). In contrast to the study in pharmacy students, the medical students received a performance analysis for the pre-test describing the individual student performance compared to his or her colleagues in the clerkship group and individual student results in specific disciplines (i.e., pulmonary, cardiology) (8). This information afforded students with areas of strength and weakness for concentration.

When utilizing MCQ for assessment, the questions should be clear, concise and correspond to measurable objectives (9). In medical education, Miller proposed a weighting of evaluation methods, where recall of factual knowledge through MCQ weighs the least and direct observation of student activity weighs the most (3). The model consists of four tiers of clinical assessment: knows (knowledge); knows how (competence); shows how (performance); and does (action). Since student performance builds on prior levels, observing student performance on a pre- and post-test may assist the preceptor with development of a comprehensive assessment plan that includes all levels of Miller’s Model. While MCQ testing has not been specifically validated for rotation assessment, such testing may lead to knowledge of how the pre- and post-test may assist the preceptor in developing a comprehensive assessment plan and facilitat-

ing student progression to the higher order activities (i.e., performance and action). The objectives of this investigation were to (1) examine the value and viability of implementation and maintenance of the assessment tool for clinical rotations; and (2) determine if post-test scores on topic specific MCQ are significantly and consistently higher at the conclusion of a pharmacy student rotation as compared with pre-test scores.

METHODS

Discovery Process

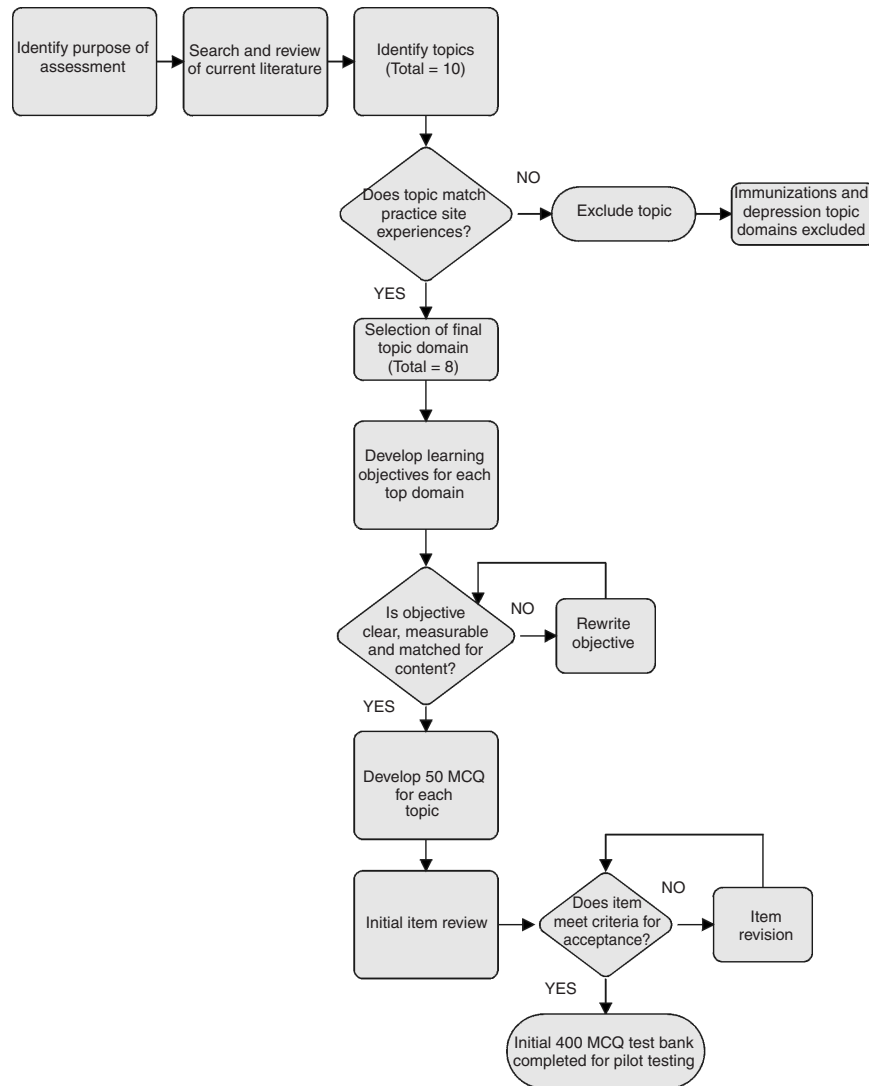
The concept of pre- and post-rotation assessment started with a single faculty member who designed an assessment process for an ambulatory care rotation. This faculty member developed and implemented over the course of one academic year a set of learning objectives, a pre-test, and a post-test. Topics in this assessment included anticoagulation, diabetes, and dyslipidemia. Anecdotally, the faculty member reported that the assessments helped her to identify baseline student deficiencies to direct educational sessions and motivate students to prepare and participate in topic discussions. Students remarked that the post-test served as positive reinforcement for learning.

As a result of these experiences, the concept was introduced at a Department of Pharmacy Practice retreat. Break-out sessions were organized by practice area to discuss the goals of a pre- and post-rotation assessment, pros and cons of such assessments, possibility of expansion, and ideas for development and implementation. A group of thirteen ambulatory care and advanced community practice faculty with significant interest in the topic proceeded with the development of an assessment tool. The faculty preceptors involved in the project had diverse clinical practice sites in ambulatory care or advanced community practice, albeit the majority of their rotations were ambulatory care in nature. Ambulatory rotations included broad primary care experiences in areas such as: anticoagulation, dyslipidemia, diabetes care, hypertension, and smoking cessation.

Development Process: Topic Selection and Test Bank

The process for topic selection and development of the test bank is outlined in Figure 1. Faculty identified ten chronic disease state topics commonly encountered by students on rotation in their practice sites:

FIGURE 1. Development of Learning Objectives and Pilot Test Bank



MCQ = Multiple choice question

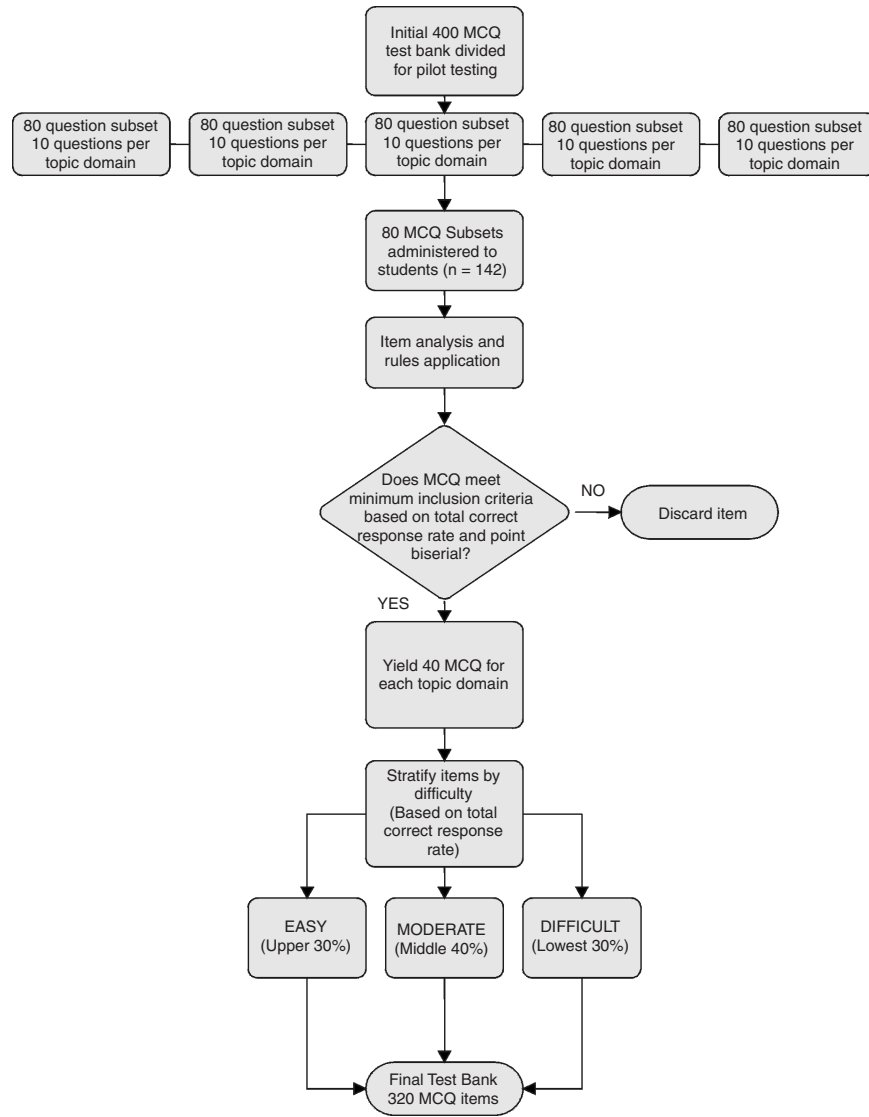
anticoagulation, atrial fibrillation, asthma, depression, diabetes, dyslipidemia, hypertension, immunizations, smoking cessation and thyroid disorders. Faculty selected topics by the likelihood of use in assessment on rotations by choosing the top three topics of interest. Based on limited interest of the faculty involved in the project, depression and immunizations were excluded, with eight topics remaining.

Pairs of faculty consisting of an author and reviewer were assigned to each topic. Faculty reviewed guidelines for writing educational objectives and MCQ (9). After this reinforcement training, faculty pairs developed a set of learning objectives for each topic and identified a set of recommended readings, such as current practice guidelines, textbook chapters or review articles. Pairs then drafted fifty questions per topic area corresponding to the learning objectives. Each faculty pair created MCQ with five choices (A-E). The choice of *all of the above* was avoided due to decreased validity with this option (9). Additionally, *none of the above* choices were avoided based on recommendations in the literature (9). Following the drafting of questions, faculty met through a series of sessions to review and revise the test bank for agreement with the following: correlation with objectives, absence of ambiguity, reflection of actual practice, clear consensus of a correct answer and required analysis, interpretation, application and/or judgment to test higher level application (8,10). Extensive revisions to assessment questions and objectives occurred as a result of this quality assessment.

Pilot Test

Following the review by faculty, a pilot test was administered to pharmacy students (n = 142) at the completion of their second professional year. The test was a mandatory activity for the Introductory Practice Experience III, a required course for second year students. Ten points representing approximately 5% of the course grade were assigned to the activity as incentive for student participation. The 500 MCQ bank was divided and each student received an exam consisting of 80 items given over 110 minutes (Figure 2). Each question was tested by 28-30 students. Students were encouraged not to prepare or study for the exam, but to answer the questions to the best of their ability. All students had completed didactic coursework in each of the topic areas. Five points were allocated for completion of the assessment and up to five points were assigned based on performance. As an added incentive, each student was provided with individual feedback by topic area on how best to prepare for rotations.

FIGURE 2. Pilot Implementation and Final Test Bank Development



MCQ = Multiple choice question

Refining the Test Bank

The overall mean on the pilot examination was 61%. Following pilot administration, the following rules were applied in order to refine the final test bank: (1) eliminate items with $\leq 50\%$ correct response AND point biserial < 0.05 , (2) eliminate items $\leq 20\%$ correct response AND point biserial < 0.25 , (3) eliminate items with lowest point biserial to yield 40 questions per topic area. The remaining questions ($n = 320$) were then stratified by level of difficulty based on total correct response rate. While this method of refining the test bank has not been previously validated, it served as a means of eliminating poorly performing or poorly discriminating questions from the bank.

Methods of Rotational Assessment and Performance Feedback

Questions were randomly assigned into sets of 10 MCQ per topic area with levels of difficulty evenly distributed. The MCQ were collated and compiled into one exam. A new comprehensive exam was created for each rotation block; however, the post-test for one rotation became the pre-test for the next rotation block. Once the exam was distributed, each preceptor selected three out of the eight prepared topics in a non-randomized fashion to form the test. The selection process was based on expected emphasis of that topic during the rotation. Doctor of Pharmacy students on rotation with faculty involved in the project completed ten MCQ per topic area for a total of thirty questions on the first day of the rotation. Students were not expected nor encouraged to study for the pre-test. The pre-test served as a baseline assessment of student knowledge for both the preceptor and the student. In addition, it allowed students to tailor self-learning strategies to address their individual deficiencies. The preceptor graded the tests and scores were reviewed with each student to identify areas of deficiency early in the course of the rotation. Preceptors had several options at this point to improve student learning. For instance, preceptors could emphasize the deficient therapeutic areas during direct patient care experiences, disease state discussions, and case presentations, or require a presentation from the student pertaining to the deficient area. The methods that preceptors used to provide feedback to students was not pre-specified or quantified in the present study.

During the last week of the rotation (week 5), preceptors administered a post-test consisting of randomly selected questions from the test bank of similar difficulty and content to the pre-test. The post-tests were graded and feedback was provided to each student by the completion of the rota-

tion. The test scores were not used as a direct method of the preceptor's assessment for the rotation grade. Quantitative indicators of improvement included overall and topic specific pre-and post-test scores. Qualitative student to preceptor and preceptor to author feedback on the value and viability of the pre-post test process was also obtained by casual feedback by preceptors to investigators.

Statistical Analysis

Data were compiled and analyzed with SPSS® software (Version 12.0, SPSS Inc., Chicago, IL). Continuous level data (test scores) were compared using the paired t-test.

RESULTS

Sixty-six students participated in the examination process over one academic year. Of the 66, two were excluded due to lack of pre-test data, while 11 were excluded due to lack of post-test data. Fifty-three complete sets of pre- and post-tests were evaluated. Seven topic areas were included in the analysis. Thyroid disease was excluded from the analysis because the subset of questions was not used. Overall improvements in mean pre-test scores (18.43 of 30 possible points) to post-test scores (23.21 of 30 possible points) in the combined topic areas were statistically significant ($p < 0.001$). Statistically significant improvements were noted in the topic areas of diabetes, dyslipidemia, and anticoagulation ($p < 0.001$). The results of the pre-test and post-tests, stratified by topic, can be found in Table 1.

DISCUSSION

The results of this study are consistent with other studies conducted with medical and pharmacy students (7,8,11). Post-test scores were significantly higher than pre-test scores. Administering a standardized assessment tool provided quantitative and qualitative benefits to students and preceptors. These benefits included the ability to identify the need for improvement in pharmacotherapy knowledgebase early in the rotation, the ability for students to tailor self-learning activities to address those needs during the rotation, and the provision of additional evidence to the student supporting their accomplishments on rotation. This process also

TABLE 1. Comparison and Pre- and Post-Test Scores in Each Topic Area (Maximum Achievable Score = 10)

Topic	N	Pre-Test Score Mean (SD)	Post-Test Score Mean (SD)	P value
Anticoagulation	31	6.45 (1.95)	8.87 (1.15)	< 0.001
Asthma	6	6.17 (1.47)	6.83 (1.47)	0.286
Atrial Fibrillation	21	6.05 (1.75)	6.86 (1.95)	0.108
Diabetes	25	6.40 (1.35)	8.24 (1.17)	< 0.001
Hypertension	18	6.00 (2.00)	6.89 (1.49)	0.088
Dyslipidemia	48	5.85 (1.83)	7.42 (1.78)	< 0.001
Smoking Cessation	5	6.60 (0.548)	8.00 (1.58)	0.135

provided opportunities for collaboration between colleagues, refined faculty objective and item writing skills, and heightened preceptor awareness of student needs during rotation.

Preceptors involved in the project reported multiple benefits to utilizing the pre-test and post-tests. Following completion of the pre-test, preceptors reported a heightened awareness of the student's deficient areas. It was the preceptor's discretion to change rotation activities as a result of the pre-test and allow students to gain experience in an area identified as deficient. Future studies may wish to formally document how pre-test scores were used in tailoring rotation activities. Even if preceptors did not restructure the rotation activities, they had the opportunity to link the tested concepts with direct patient care experiences to improve student retention of the material. Preceptors also noted the results of the pre-test prompted students to focus their self-directed learning in a deficient topic area. Students using portfolios in self-assessment may be able to use results of pre-testing to develop an individualized plan for self-learning.

Finally, preceptors reported that completion of the pre- and post-test and subsequent improvement provided additional evidence to the student supporting their accomplishments on rotation. The results of the pre- and post-tests were not included in the rotation grade; however, the results provided additional information for the preceptor to thoroughly assess student performance. MCQ are appropriate to use for assessment if students "know" and "know how" to utilize the factual information (2). Preceptor observation of student activities in the clinical setting cannot be replaced by MCQ assessments. However, preceptors' overall assessment may be enhanced through inclusion of pre-post rotation assessment in addition to direct observation. A logical next step is to determine if the as-

assessment process impacts student performance in other rotation activities assessed by observation only.

In one study, a comprehensive examination was developed with the intent of individualizing student placement in experiential courses and, if appropriate, identifying students requiring remediation (12). The results did not demonstrate a correlation between the results on the comprehensive examination and grades in experiential courses. However, the authors identified the exam as a useful tool to identify students requiring remediation. Perhaps limiting the assessment topics in the present study to three or four in one rotation type, will allow students to better focus their attention. If each rotation type initiated a similar pre- and post-test assessment, it is possible that specific objectives of the Gehres study can be achieved: (1) student deficiencies in specific therapeutic areas would be identified; and (2) remedial learning materials can be developed. The relationship between a comprehensive examination and rotation grades could be explored to strengthen the experiential education curriculum and enhance corresponding assessment tools. It is also important to determine the impact of pre-post rotation assessment on student motivation. Does completion of a pre-test assessing baseline knowledge motivate students to perform at a higher level during the rotation? If so, students may develop higher level skills earlier in the course of the rotation, and responsibilities can be matched to their respective level.

For other educators interested in implementing a similar process, it is important to note this is a time intensive process. Educators are encouraged to tie this process into their current institutional assessment program. Doing so may assist with streamlining assessment tools and decreasing the duplication of time or efforts designed to assess student learning. Development of the objectives and test instrument, pilot testing, test administration and grading of tests during the rotation may require a significant amount of time, especially if multiple faculty at different locations are collaborating on such a project. Also, with changes in clinical practice, continuous updating of learning objectives and items is required. As the ultimate goal of a rotation is to observe students performing actual patient care, testing which may assist a student in achieving this goal maintains utility (7). Therefore, the investigators believe the pre-test is the most useful component of this process. Faculty may be interested in implementing pre-testing alone to identify opportunities for improvement early in a rotation. This requires development of a smaller test bank and devotes less time to individual student testing.

One potential solution to the time intensive process of paper examinations would be utilization of a computerized examination process with

automated scoring. Computerized exams and grading would reduce the time required for the preceptor to grade individual tests and offer the potential advantage of immediate feedback to the students regarding current performance. In one medical school-based study, a web-based question database was developed for student self-assessment of learning on an obstetrics and gynecology rotation (13). The system allows for test questions in varied formats, including essay, extended-matching and short fill-in response. Students received questions from the database in the form of 10-question quizzes. Feedback was provided after each question, as well as in summary at the end of each quiz. Authors noted that the computerized testing process helped to identify student deficiencies early in the rotation.

One limitation to the present study included the small sample size and corresponding limited interpretation of changes between pre- and post-test scores, especially in those topic areas not frequently used, such as asthma and smoking cessation. While the test items were assessed for content validity by matching competency goals with the content of the items in the test bank, a formal task analysis of the rotation itself and a principal component analysis of questions within the bank was not performed. Tasks and responsibilities of students may have varied at different rotation sites and individual preceptor teaching style may have an impact on student learning. As a result, students may have performed better on the post-test in topics in which they received repeated exposure, rather than occasional exposure. Alternatively, a difference in knowledge may not be achieved for those topics in which superior baseline knowledge was evident. For example, if students had been exposed to anticoagulation in a previous rotation, baseline scores for fundamental knowledge would be high. While the rotation would afford potential to explore specialty areas of anticoagulation, the rotation would not likely affect the already high degree of core knowledge of this content area. Further, while categorization of the test items by level of difficulty assists in creating a pre- and post-test similar in difficulty level, there is no certainty that the tests are equivalent. This could be one reason improvements in scores were observed in some topic areas, but not in others.

While the process of writing and screening test items refined our test bank from pilot to the final bank, future studies may wish to subject the items to a test of internal consistency, such as the Kuder-Richardson 20 (KR – 20). Item-response theory, including Rasch modeling, may also be used to refine the tool used in estimating individual abilities across content areas. Future efforts may also discern the type of testing (multiple-choice, direct observation, simulated experiences, verbal examinations, or

written examinations) that provides the most useful baseline assessment in the clinical setting. Future research also may include gathering student feedback to further analyze the perceived impact by students. Anecdotally, students reported post-test scores helped boost their confidence and provided direct evidence of learning during the rotation. This may be particularly important since the majority of pharmacy students are now female (14). In one study of medical students on a surgery rotation, female students significantly underestimated their performance in self-assessment compared with formative and summative evaluations provided by feedback (15).

CONCLUSION

This project demonstrated overall post-test scores which were significantly and consistently higher at the conclusion of a rotation as compared with pre-test scores. The pre-testing tool provides both quantitative and qualitative benefits to both students and preceptors, further enhancing the ability to tailor experiential learning during rotations to the individual student. Implementing a pre- and post-test assessment activity warrants further investigation to determine if student outcomes such as increased confidence, improved problem solving ability, and improved ability to provide pharmaceutical care, are achieved.

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REFERENCES

1. Accreditation Council for Pharmacy Education. Draft revision of ACPE standards 2000 and proposed guidelines. Chicago: American Council for Pharmacy Education: June 2005 [cited 1 July 2005]. Available from: <http://www.acpe-accredit.org/standards/default.asp>.
2. Beck D, Boh L, O'Sullivan P. Evaluating student performance in the experiential setting with confidence. *Am J Pharm Educ* 1995; 59:236-247.
3. Miller GE. The assessment of clinical skills/competence/performance. *Acad Med* 1990; 65:S63-7.
4. Boh L, Pitterle M, Schneider F, et al. Survey of experiential programs: Course competencies, student performance and preceptor/site characteristics. *Am J Pharm Educ* 1991; 51:105-113.

5. Elenbaas R. Evaluation of students in the clinical setting. *Am J Pharm Educ* 1976; 40:410-417.
6. Smith H, Kifer E. Concepts, models and methodologies for the evaluation of experiential education in pharmacy. *Am J Pharm Educ* 1978; 42:159-167.
7. Erstad B, Favre J. Written testing of students in the experiential setting. *Am J Pharm Educ* 1999; 63:426-429.
8. Holmes FF, Hearne EM, 3rd. Pre-test and post-test in a medicine clerkship. *Med Educ* 1980; 14:434-437.
9. Schultheis NM. Writing cognitive educational objectives and multiple-choice test questions. *Am J Health Syst Pharm* 1998; 55:2397-2401.
10. Smith H, Kifer E. Student evaluation in an externship utilizing the Rasch model for test calibration. *Am J Pharm Educ* 1980; 44:6-11.
11. Butterfield PS, Libertin AG. Learning outcomes of an ambulatory care rotation in internal medicine for junior medical students. *J Gen Intern Med* 1993; 8:189-92.
12. Gehres R, Mergener M, Sarnoff D. Comprehensive placement examination for sequencing pharmacy students into experiential courses and for determining appropriate remediation. *Am J Pharm Educ* 1989; 53:16-19.
13. Hammoud MM, Barclay ML. Development of a web-based question database for students' self-assessment. *Acad Med* 2002; 77:925.
14. Fall 2004 Profile of Pharmacy Students. Alexandria, VA: American Association of Colleges of Pharmacy, 2005.
15. Lind DS, Rekkas S, Bui V, et al. Competency-based student self-assessment on a surgery rotation. *J Surg Res* 2002; 105:31-34.