Relationship between an Annual Examination to Assess Student Knowledge and Traditional Measures of Academic Performance

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The Bernard J. Dunn School of Pharmacy requires that all students take an annual examination regarding curricular performance in the Doctor of Pharmacy program. The present investigation assessed the convergent validity of this annual multifaceted written examination with other markers of success in fourth-year pharmacy students. The concept of convergent validity implies that a construct should be correlated with theoretically similar constructs. Convergent validity of the annual examination was examined by correlating the results obtained on the annual examination with other measures thought to be predictors of student performance. Such measures include final grade point average, pre-pharmacy grade point average, PCAT scores, and the possession of an undergraduate degree prior to entering pharmacy school. Results indicated that the annual examination correlated significantly with final grade point average and students' composite PCAT percentile scores, but not with pre-admission grade point average or obtaining an undergraduate degree prior to beginning pharmacy school.

INTRODUCTION

The American Association of Colleges of Pharmacy Commission to Implement Change in Pharmaceutical Education and the Focus Group on Liberalization of the Professional Curriculum defined the need to use outcome measures in designing curricula and assessing student learning(1,2). These committees encouraged ability-based education, whereby curricula are designed so that Doctor of Pharmacy students can demonstrate general and professional outcome abilities. General ability outcomes include such skills as critical thinking, decision-making, communication, ethics, and citizenship, whereas professional abilities are considered general abilities specifically applied to the provision of pharmaceutical care(3).

Using these initiatives as guidelines, Shenandoah University's Bernard J. Dunn School of Pharmacy decided to utilize an annual examination as one component of student assessment to ensure that students are not only developing a knowledge base, but retaining one as well. In addition, results of this examination could be used to identify potential weaknesses in the curriculum, as well as facilitate curricular effectiveness(4). One component of the examination is written. Students are required to take this examination during each of their professional pharmacy years.

The major objective of this project was to assess the convergent validity of the annual multifaceted written examination with other markers of success in fourth-year pharmacy students. The concept of convergent validity implies that a construct should be correlated with theoretically similar con-

structs(5). The convergent validity of the annual examination was assessed by correlating the obtained results on the annual examination with other measures thought to be predictors of student performance, such as final grade point average, pre-pharmacy grade point average, PCAT scores, and possessing an undergraduate degree prior to entering pharmacy school.

The remainder of this paper is organized as follows. First, the relevant literature pertaining to academic performance in pharmacy is reviewed. Next, one hypothesis is advanced and the methods and results of the present investigation are discussed. Finally, implications and limitations are discussed, along with potential avenues of future research.

LITERATURE REVIEW

In the health professions, there is general agreement that indicators such as undergraduate grade-point average (GPA), Pharmacy College Admissions Test (PCAT), and the achievement of a four-year degree prior to entering pharmacy school are predictors of academic performance(6-10). Chisholm, et al. reported that the greatest predictors of first-year GPA included pre-pharmacy math/science GPA and the achievement of a four-year college degree prior to entering pharmacy school(6). Hardigan, et al. reported that mathematics GPA, pre-pharmacy cumulative GPA, reading PCAT, faculty interview, and composite PCAT were significant predictors of pharmacy students' first-year GPA(7).

Kelley examined the predictive nature of pre-pharmacy GPA and the PCAT on pharmacy students' first-quarter GPA(8). It was reported that both variables were significant predictors of students' GPAs. Charupatanapong revealed that those students who had lower pre-pharmacy GPAs and who were older were more likely to perform at lower levels of academic performance(9). Meleca reported that significant predictors of academic performance among medical students included undergraduate GPA and scores on the Medical College Admission Test (MCAT)(11). Academic performance was measured as students' average academic performances on three National Board of Medical Examiners subject examinations in the basic sciences (anatomy, physiology, and biochemistry). Based on the notion that the annual examination purports to measure similar concepts and outcomes as traditional measures of academic performance, the following hypothesis is advanced:

H1: Scores on the annual examination of the class of 2000 will be significantly correlated in the positive direction with composite PCAT pre-admission GPA, final GPA, and obtaining an undergraduate degree prior to pharmacy school.

METHODS

This investigation utilized a convenience sample, and was a blinded retrospective record review of Shenandoah University's first graduating Doctor of Pharmacy class, the class of 2000. Students were given the annual written examination during the spring semester of their fourth professional year. Thus, all 65 students in the class took it during the spring of 2000. The examination is a multifaceted, dynamic examination designed to assess proficiency and performance related to each required course taken at Shenandoah during the prior three years. Students' scores can range from 0 to 100 percent. As discussed previously, this investigation only examined the written portion of the examination, and not the students' skills portion.

The annual examination is based on competencies within twelve distinct domains, called *The Shenandoah Twelve*[1]. The Shenandoah Twelve expected competencies include:
1. communication
2. using scientific explanation in the practice of pharmacy
3. problem prevention and solving
4. dispensing of Pharmaceuticals
5. providing pharmaceutical care to individual patients
6. providing pharmaceutical care to patient populations
7. social and professional interaction and teamwork
8. personal, ethical and legal judgment
9. personal and professional growth
10. management skills
11. advancement of pharmacy and health care
12. promotions of good health and public welfare

The first competency expectation is communication. The competent graduate is expected to listen attentively and communicate clearly, both orally and in writing, with patients, families, and health care team members. The graduate establishes the rapport necessary to form and to sustain an effective therapeutic relationship.[1] For example, the written examination might include a scenario based on trust and empathy whereby the student is required to develop a trusting and empathic response to a specific practical scenario in order to establish and build rapport with a patient.

One component under the management section of the Shenandoah 12 pertains to competency in performing pharmacoeconomic analysis. The following is a question designed to tap this competency:

As a recent graduate of the Bernard J. Dunn School of Pharmacy you are asked to compare the costs and patient outcomes of two treatments for colon cancer: surgery alone, which is the standard of treatment, and surgery followed by 30 weeks of chemotherapy. After intense analysis, you estimate the direct medical costs of surgery to be $10,000 per patient and the direct medical costs of surgery and chemotherapy to be $20,000. The average life expectancy for a patient receiving surgery alone is estimated to be 12.50 years as compared with 15.25 years for a patient treated with both surgery and chemotherapy. What is the incremental cost-effectiveness ratio for surgery plus chemotherapy?

Faculty members contribute questions, based on their areas of expertise. They are encouraged to provide questions in a scenario format, and to write the questions at the higher levels of Bloom's taxonomy(12). Bloom and his colleagues developed a taxonomy of intellectual behavior important in learning. One domain, cognition, includes six levels ranging from the simple recall or recognition of facts to the more complex levels of analysis, synthesis, and evaluation. The questions on the written annual examination are "validated" by multiple student, faculty, and practitioner groups. Figure 1 shows one such question: This question revolves around three components of the Shenandoah 12: (*i*) using scientific explanation in the practice of pharmacy; (*ii*) problem prevention and solving; and (*iii*) providing pharmaceutical care to individual patients.

Since the object of this investigation was to assess the convergent validity of an annual multifaceted written exam with other markers of success in fourth-year pharmacy stu-

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[1]Assuring Excellence: An Academic Plan for the Shenandoah University School of Pharmacy, Shenandoah University, Bernard J. Dunn School of Pharmacy, Winchester VA(2000).

A patient with nosocomial pneumonia has a sputum culture positive for *Pseudomonas aeruginosa* and *Klebsiella oxytoca*. The sensitivity pattern is as follows:

	P. aeruginosa	K. ocytoca
Amikacin	S	S
Ampicillin	R	R
Ceftriaxone	R	S
Ceftazidime	S	S
Ciprofloxacin	R	S
Gentamicin	R	S
Imipenem	S	S
Piperacillin	S	S
Tobramycin	S	S

Which of the following antibiotic combinations could be used to treat this patient?
a) amikacin and ceftriaxone
b) gentamicin and piperacillin
c) tobramycin and ceftazidime
d) ciprofloxacin and imipenem

Fig. 1. Annual examination question.

dents, the Pearson product moment coefficient of correlation statistical technique was used to examine data.

RESULTS

The class of 2000 was the first Doctor of Pharmacy class at Shenandoah University. Table I reports on the descriptive statistics of this class. Tables II through IV report data concerning the major goal of this investigation: the relationship between scores on the annual written examination and traditional measures of academic performance. The Pearson r correlation revealed a significant correlation at the 0.01 alpha level for the relationships between the annual examination and both final grade point average and percentile scores on the composite PCAT. The relationship between the annual examination and pre-admission GPA approached significance at the 0.10 alpha level ($r=0.201$). However, a one-way ANOVA revealed that there was no relationship between scores on the annual examination and obtaining an undergraduate degree prior to attending pharmacy school.

DISCUSSION

The major objective of this investigation was to assess the convergent validity of an annual written examination with traditional measures of academic performance. To do this, a hypothesis was advanced predicting the relationship between annual written examination performance and traditional measures of academic performance. In other words, this study sought to answer the question: is the annual examination given to Doctor of Pharmacy students at Shenandoah University related to: (*i*) pre-admission GPA; (*ii*) final GPA; (*iii*) composite PCAT percentile score; and (*iv*) possessing an undergraduate degree prior to pharmacy school? This hypothesis was partially supported. Results for the class of 2000 indicated that there was a significant relationship at the 0.01 alpha level between the annual written examination and two measures of academic performance: final GPA and composite PCAT percentile score. Pre-admission GPA and the annual written examination approached significance at the 0.10 alpha level, while there was no relationship between the annual written examination and obtaining an undergraduate degree prior to attending pharmacy school. Explanations for why the annual examination was not significantly correlated to either pre-admission GPA or

Table I. Descriptive statistics of the class of 2000

Variable	N	Mean	SD	Frequency
Gender	65			
Male				27
Female				38
Age (years)	65	24	4.93	
Race	65			
White				52
Asian				13
Annual examination	65	51.57	8.16	
Composite PCAT	65	51.54	25.98	
Pre-GPA	65	3.08	0.35	
Prior degree	65			
Yes				38
No				27
Final Shenandoah GPA	65	3.16	0.35	

Table II. Correlation between final pharmacy grade point average (SHENGPA) and performance on the annual written examination

Variable	Mean	SD	1	2
Shenandoah GPA	3.1646	0.3490	1.00	0.349**
Annual exam	51.5612	8.1585		1.00

** Significant at the 0.01 alpha level.

Table III. Correlation between composite PCAT and performance on the annual written examination

Variable	Mean	SD	1	2
Composite PCAT	51.54	25.98	1.00	0.485**
Annual exam	51.5612	8.1585		1.00

** Significant at the 0.01 alpha level

Table IV. Correlation between pre-admission GPA and performance on the annual written examination

Variable	Mean	SD	1	2
Pre-admission GPA	3.08	0.35	1.00	0.201
Annual exam	51.5612	8.1585		1.00

the obtainment of an undergraduate degree prior to attending pharmacy school require speculation. Previous studies demonstrated a correlation between pre-admission GPA, possessing an undergraduate degree prior to attending pharmacy school, and first-year GPA in pharmacy school (as the dependent variable), rather than other measures of academic performance [*e.g.,* annual examination, final GPA(6,8)]. Therefore, it is difficult to speculate on why these two indicators were not significantly predictive of examination performance. Additional studies must be conducted with more classes using the annual examination before explanations can be offered.

This investigation is a first step in examining alternative measures of academic performance in pharmacy students. By demonstrating a significant relationship between the annual examination and important measures of academic performance such as final GPA and composite PCAT percentile scores, it can be stated that, at least in this sample, the annual written examination may be measuring similar constructs as other measures of academic performance. However, the intent of the annual written examination is to tap students' critical thinking skills

consistent with the Shenandoah Twelve and based on the higher levels of Bloom's taxonomy(12). In addition, the annual examination assesses student knowledge not subject to short-term memory. In other words, since the examination is a cumulative one based on the prior three years of didactic instruction (for the class of 2000), students could not prepare in advance for it. Thus, the annual examination may be an additional method of assessing student knowledge by assessing what students retain during their pharmacy education.

The results obtained are preliminary and are subject to limitations. Specifically, a convenience sample was used and it only assessed one class of pharmacy students. It is possible that different results could be obtained with different classes and at different schools of pharmacy. In addition, it must be pointed out that, in the strictest sense, the annual examination measures retained knowledge as opposed to components of clinical performance. Also, although faculty members are encouraged to submit examination questions that capture the general content of their courses, there can be no guarantee that each question achieves this goal. Thus, before final conclusions can be made, additional studies are needed with different classes to determine the reliability of this investigation.

Despite these caveats, this investigation does demonstrate that the annual examination is significantly related to traditional measures of academic performance. What are the implications of schools of pharmacy assessing students via an annual examination? The results can be used to identify student strengths and weaknesses in the curriculum, and, if necessary to design educational interventions to address weaknesses in specific academic areas. It could also be used as a condition of graduation (since it purports to measure retained knowledge). If that option were exercised, students may take the process more seriously than if it were not used as a condition of graduation. In addition, the annual examination provides information for the appropriate national accrediting agencies pertaining to student assessment.

CONCLUSION

The major objective of this investigation was to examine the relationship between performance on the annual written examination and traditional measures of academic performance in pharmacy students. Results partially support the advanced hypothesis. Specifically, the annual examination correlates significantly with final GPA and students' composite PCAT percentile scores.

References

(1) Commission to Implement Change in Pharmaceutical Education, "Background Paper II. Entry-level curricular outcomes, curricular content and educational process," *Am. J. Pharm. Educ.*, **57**, 377-385(1993).

(2) Chalmers, R.K., Grotpeter, J.J., Hollenbeck, R.G., Nickman, N.A., Sommi, R.W., Zlatic, T.D., Loacker, G. and Meyer, S.M., "Changing to an out-come-based, assessment-guided curriculum: A report of the focus group on liberalization of the professional curriculum," *ibid.*, **58**, 108-114(1994).

(3) Meyer, S.M., "Student assessment: A component of providing quality education," *ibid.*, **58**, 106-107(1994).

(4) Stall, R., "Using an annual examination to assess student progress and the curriculum at Shenandoah University School of Pharmacy," *ibid.*, **62**, 107S(1998).

(5) Kerlinger, F.N., *Foundations of Behavioral Research,* 3rd ed., Holt, Rinehart and Winston, New York NY (1986) p. 421.

(6) Chisholm, M.A., Cobb, H.H. and Kotzan, J.A., " Significant factors for predicting academic success of first-year pharmacy students," *ibid.*, **59**, 364-370(1995).

(7) Hardigan, P.C., Lai, L.L., Ameson, D. and Robeson, A., "Significance of academic merit, test scores, interviews and the admissions process: A case study," *ibid.*, **65**, 40-44(2001).

(8) Kelley, K., "The pharmacy college admissions test (PCAT) as a predictor of success at the Ohio State University," *ibid.*, **65**, 104S(2000).

(9) Charupatanapong, N., McCormick and W.C., Rascati, K.L., "Predicting academic performance of pharmacy students: Demographic compare-risons," *ibid.*, **58**, 262-268(1994).

(10) Lowenthal, W., "Relationship among student admission characteristics, licensing examinations and academic performance: A comparison of three graduating classes," *ibid.*, **45**, 132-139(1989).

(11) Meleca, C.B., "Traditional predictors of academic performance in a medical school's independent study program," *Acad. Med.*, **70**, 59-63(1995).

(12) Bloom, B. S. and Krathwohl, D.R. *Taxonomy of Educational Objectives: The Classification of Educational Goals,* by a Committee of College and University Examiners. Handbook I: Cognitive Domain, Longmans Green, New York NY (1956)