American Journal of Pharmaceutical Education **2003; 67 (4) Article 109.**

RESEARCH ARTICLES

Traditional and Novel Predictors of Classroom and Clerkship Success of Pharmacy Students

Robert S. Kidd, PharmD, and David A. Latif, PhD

Shenandoah University, Bernard J. Dunn School of Pharmacy

Objectives. This study was designed to assess the extent to which 7 traditional and novel predictors contribute to overall pharmacy grade point average (pharmacy GPA), first through third year pharmacy GPA (1-3 year GPA), and clerkship GPA of pharmacy students.
Methods. This investigation used a convenience sample and a blinded retrospective record review of the first 3 class years of Doctor of Pharmacy students at Shenandoah University's Bernard J. Dunn School of Pharmacy (Classes of 2000, 2001, and 2002).
Results. Pharmacy College Admissions Test (PCAT) score, essay score, California Critical Thinking Dispositions Inventory (CCTDI) and Skills Test (CCTST) were all significant predictors of pharmacy GPA. PCAT and CCTDI contributed significantly to 1-3 GPA. Finally, only the CCTST proved to be a significant predictor of the clerkship GPA.
Conclusion. This study corroborated previous studies by concluding that several traditional predictors of students' performance appear to significantly predict academic outcomes. However, it advances the study of predictors of pharmacy students' performance by examining the role of critical thinking in students' performance.

Keywords: assessment, student performance, pharmacy students, success, grade point average, critical thinking, clerkship

INTRODUCTION

Idenitfying those applicants who are most likely to have success in classroom courses, and more importantly, those who are most likely to develop into competent practitioners is critical to both the mission of pharmacy schools and the profession of pharmacy. This determination process has long been a challenge for members of admission committees in schools of pharmacy. Numerous studies have been conducted to determine which preadmission criteria are the best predictors of various measures of academic success. Those quantitative and qualitative variables previously examined include the Pharmacy College Admissions Test (PCAT) in part or in whole, prepharmacy grade point average (GPA), math and science course grades, involvement in extracurricular activities, age, gender, marital status, ethnicity, achievement of a 4-year college degree, rank of the applicant's undergraduate school, personal interview scores, Myers-Briggs Type Indicator (MBTI), and California Critical Thinking Skills Test (CCTST).[1-20] There is general agreement that many of these factors are predictors of academic performance. For example, Charupatanapong et al reported that older pharmacy students with lower prepharmacy GPAs were more likely to perform at lower academic levels.[16]

Chisholm et al demonstrated that the greatest predictors of the GPA of first-year pharmacy students included their prepharmacy math/science GPAs and whether they had completed a 4-year undergraduate degree prior to entering pharmacy school.[17]

Allen et al examined several prepharmacy predictors of success in pharmacy schools. The authors reported that the best predictors for the first professional year were a student's overall prepharmacy GPA, GPA for required prepharmacy courses, and PCAT scores.[18] The strongest predictors of success in practice-related courses and clerkships were PCAT scores and the

Corresponding Author: Robert S. Kidd, PharmD. Mailing Address: Department of Biopharmaceutical Sciences, Shenandoah University Bernard J. Dunn School of Pharmacy, 1775 North Sector Court, Winchester, VA 22601. Tel: 540-545-7217. Fax: 540-665-1283. E-mail: rkidd@su.edu.

CCTST. Hardigan et al reported that prepharmacy mathematics GPA, cumulative prepharmacy GPA, verbal PCAT scores, faculty interview, and composite PCAT scores were all significant predictors of pharmacy students' first-year GPA.[19]

Most of these studies evaluated the potential predictors in relation to success early in the professional curriculum. The present investigation differs from these by examining not only predictors of performance in classroom-based courses in the first through third professional years, but also predictors of professional performance using the GPA for 4th professional year clerkships. One of many issues addressed by the American Association of Colleges of Pharmacy's Commission to Implement Change was admission criteria, policies, and procedures. These recommendations were subsequently adopted in 1997 in the Accreditation Standards and Guidelines for the Professional Program of Pharmacy leading to the Doctor of Pharmacy Degree of the American Council on Pharmaceutical Education (ACPE).[21] Guideline 16.5 states "Studies are encouraged that relate admissions criteria with student achievement in the professional program in pharmacy and performance in professional practice." Assessing how admission criteria correlate to performance in professional practice is more difficult than assessing how it correlates to classroom success. The main difficulty is identifying quantitative and/or qualitative measures of performance in a practice setting. Because of this problem, the value of many of these variables has not been thoroughly examined in relationship to performance of pharmacy students in a professional practice setting.

Guideline 16.3 of the ACPE Standards states "Admissions criteria, policies, and procedures should give consideration not only to scholastic accomplishments, but also to other factors such as motivation, industry, and communication capabilities that show the student's potential to become a life-long learner and an effective professional." To this end, applicants to our school are required to complete an application packet before consideration for matriculation is given. A complete packet includes an application, a copy of all undergraduate transcripts, PCAT score, and 3 letters of reference. The admissions committee examines transcripts based on both required prerequisites, and all prior pre-professional courses taken, which may include more courses than the required ones. In addition, an on-campus interview with current faculty members and students and an on-campus, timed essay is required. Entering students also undergo several other evaluations including the CCTST and the California Critical Thinking Dispositions Inventory (CCTDI) during the orientation period at the beginning of the first professional year.

The on-campus interview is evaluated with a 10-item instrument using a Likert scale with a 55-point maximum score. Its primary purpose is to assess candidates on interpersonal, motivational, and critical thinking characteristics. The on-campus, timed essay is a 30-minute exercise to evaluate a candidate's written communication skills. The timed essays are all evaluated by a single faculty member using a 4-parameter Likert-scale instrument that has a 35-point maximum score.

The CCTST is a standardized 34-item multiple-choice instrument that evaluates and reports scores on one's analysis skills, evaluation skills, inference ability, deductive reasoning, inductive reasoning, and overall critical thinking. The CCTDI is a standardized 75-item instrument with all responses recorded using a 6-point Likert scale. It is designed to measure an individual's disposition toward using his or her critical thinking skills in any given situation. Other tests used to examine critical thinking skills include the Watson-Glaser Critical Thinking Skills Assessment, the Cornell Critical Thinking Skills Test, and the Collegiate Assessment of Didactic Proficiency Critical Thinking Test. However, the authors are not aware of any literature reports describing their use in pharmacy education.

The CCTST and CCTDI are being evaluated as possible admission criteria to assist in predicting an applicant's potential to become an effective professional and a life-long learner. A very important aspect of delivering pharmaceutical care is the practitioner's ability and inclination to critically analyze situations. Therefore, we are assessing the significance of evaluating an applicant's critical thinking skills and inclination. In addition, our curriculum includes several problem-based learning courses to assist our students in develop their critical thinking skills. The curriculum is also designed to transition students into independent practitioners and life-long learners by beginning with group assignments and transitioning to individual projects by the end of the third year of the professional curriculum. Therefore, based on the apparent importance of these skills, this study was designed and conducted to evaluate the relative ability of these variables to predict both academic and practice setting performance as recommended by ACPE accreditation standards. For purposes of this study, professional practice performance was operationalized as students' grade point average on their fourth professional year experiential rotations.

Table 1. Influence of Preadmission Indicators on Overall Pharmacy GPA

Indicator	N	Mean (SD)	Beta Coefficient	Significance
PCAT	139	52.3 (28.32)	0.30	0.001*
Required prepharmacy GPA	139	3.0 (0.34)	0.11	0.358
Cumulative prepharmacy GPA	139	2.9 (0.43)	0.22	0.062
Interview	137	42.2 (5.71)	-0.04	0.580
Essay	137	25.6 (4.96)	0.17	0.017†
CCTDI	139	310.1 (30.81)	0.15	0.028†
CCTST	139	16.5 (4.15)	0.19	0.033†

* Significant at the 0.01 alpha level
† Significant at the 0.05 alpha level.

METHODS

Prior to beginning our research, this study was approved by the Human Subjects Review Board of Shenandoah University. This investigation used a convenience sample and was a blinded retrospective record review of the first 3 class years of Doctor of Pharmacy students at Shenandoah University's Bernard J. Dunn School of Pharmacy (Classes of 2000, 2001, and 2002). A power analysis, based on an estimated moderate effect size, used a 0.80 convention to determine the proper sample size. Based on this analysis, using a 0.01 significance level, 80 students were needed for this investigation.[22] Complete records were obtained from 139 of the 187 students in 3 classes of students. A Student's t-test was used to determine if those students for which we had complete records were significantly different from those for which we did not have complete records. A one-way ANOVA was used to determine if the classes were systematically different from each other on the variables of interest.

The CCTST, CCTDI, PCAT, required prepharmacy GPA, cumulative pre-pharmacy GPA, essay score, and interview score served as independent variables and were assessed in relationship to the students' overall pharmacy GPA (ie, cumulative GPA during their 4 professional years), first through third year pharmacy GPA (ie, cumulative GPA for all 50 courses during the first 3 professional years, 1-3 year GPA) and clerkship GPA during the fourth professional year (ie, cumulative GPA for all 7 experiential clerkships during the fourth professional year) by multiple regression analysis. The GPAs were calculated as a numerical weighted average based on the course credit hours and quality points of the letter grade achieved (ie, A = 4.0, B = 3.0, C= 2.0, and D = 1.0). Finally, colinearity analysis was performed to assess if multicolinearity was a problem. A priori significances were set at the 0.05 alpha level. SPSS v.10 software (SPSS, Inc., Chicago, Illinois) was used to evaluate the data for statistical significance.

RESULTS

Using PCAT scores, required prepharmacy GPA, and cumulative prepharmacy GPA as dependent variables, the Student's t-test revealed that those students for which we had complete records were not significantly different from those for which we did not have complete records. A one-way ANOVA revealed that students enrolled in each of the class years were not significantly different from each other based on the variables of interest. Therefore, we concluded that the classes were not systematically different from one another in terms of markers of academic performance.

The first analysis examined the influence of the 7 independent variables on students' overall pharmacy GPA. The model contributed significantly to students' overall pharmacy GPA ($p = 0.001$). As shown in Table 1, PCAT, essay, CCTDI, and CCTST all contributed significantly at the 0.05 alpha level to overall pharmacy GPA. Colinearity analysis revealed that multicolinearity did not appear to be a problem with this sample.

The second analysis examined the influence of the same 7 independent variables on students' 1-3 year GPA. The model contributed significantly to students' 1-3 year GPA ($p < 0.001$). As shown in Table 2, PCAT and CCTDI were the only variables to contribute significantly at the 0.05 alpha level to 1-3 year GPA. Colinearity analysis revealed that multicolinearity did not appear to be a problem with this sample.

The third analysis examined the relationship between the same 7 independent variables and the students' clinical performance as measured by the clerkship GPA (actual performance on the fourth professional year experiential rotations). The model significantly contributed to clerkship GPA ($p = 0.008$). How-

Table 2. Influence of Preadmission Indicators on first through third year pharmacy GPA

Indicator	N	Mean (SD)	Beta Coefficient	Significance
PCAT	139	52.34 (28.32)	0.40	< 0.001
Required prepharmacy GPA	139	3.09 (0.34)	0.22	0.060
Cumulative prepharmacy GPA	139	2.91 (0.43)	0.17	0.139
Interview	137	42.23 (5.71)	-0.04	0.508
Essay	137	25.61 (4.96)	0.11	0.093
CCTDI	139	310.15 (30.81)	0.14	0.046†
CCTST	139	16.58 (4.15)	0.038	0.665

* Significant at the 0.01 alpha level; †Significant at the 0.05 alpha level.

Table 3. Influence of Preadmission Indicators on Clerkship GPA

Indicator	N	Mean (SD)	Beta Coefficient	Significance
PCAT	139	52.34 (28.32)	-0.18	0.105
Required prepharmacy GPA	139	3.09 (0.34)	-0.08	0.595
Cumulative prepharmacy GPA	139	2.91 (0.43)	0.02	0.897
Interview	137	42.23 (5.71)	0.04	0.648
Essay	137	25.61 (4.96)	0.14	0.121
CCTDI	139	310.15 (30.81)	0.17	0.056
CCTST	139	16.58 (4.15)	0.30	0.006*

* Significant at the 0.01 alpha level

ever, as Table 3 reveals, of the 7 independent variables, only the CCTST made a significant contribution to clerkship GPA at the 0.05 alpha level ($p = 0.006$). The other critical thinking marker, CCTDI, approached significance at the 0.05 alpha level ($p = 0.056$). Again, colinearity analysis was performed and it did not appear that multicolinearity was a problem.

DISCUSSION

The determination of accurate predictors of applicants who are more likely to have success in classroom courses, and more importantly the ones who are more likely to develop into competent practitioners in the practice setting, is critical to both the mission of schools of pharmacy and the profession of pharmacy. This study confirms previous findings from several studies that an applicant's PCAT is a good traditional predictor of a student's academic success in pharmacy school. Most studies have evaluated the PCAT alone or in combination with GPA in relation to performance in the first year of pharmacy school and found it to be a good predictor of various measures of success. Chisholm et al performed a comprehensive review of studies evaluating the PCAT as a predictor of success.[17] This study extends those finding and demonstrates a significant correlation between PCAT score and classroom-based course success, as well as overall success in pharmacy school. It also identifies the on-campus timed essay, CCTST, and CCTDI as accurate predictors of students' overall success. The report by Allen et al is the only other study to examine a standardized critical thinking exam in pharmacy students, and they identified the CCTST to be a strong predictor of practice-related and clerkship success, but not overall success.[18] Finally, this investigation identifies the CCTDI as an accurate predictor of success in first through third year classroom-based courses that has not previously been examined as a predictor of success in pharmacy students.

Students' performance during the practice-based clerkships in the fourth professional year was used as a measure of their ability to function as competent practitioners since these courses more accurately replicate actual pharmacy practice. In addition to a sufficient knowledge base gained during the first three years of the pharmacy curriculum, a successful practitioner must possess adequate critical thinking and problem-solving skills to face the day-to-day challenges of professional practice.

This investigation demonstrated that, of all the indictors examined, only CCTST significantly contributed to clerkship GPA at the 0.05 alpha level. Interestingly, PCAT scores, while a significant contributor to career success and success in classroom-based courses,

were not a contributor to success in fourth professional year experiential rotations. These results corroborate a previous study that reported a significant correlation between CCTST and students' clinical performance as measured by fourth professional year experiential rotation grades.[18]

This study is the first one in pharmacy education that has examined CCTDI, which was shown to have predictive power for overall academic success and success in classroom-based courses as well as a trend indicating professional practice success ($p = 0.056$). The disposition towards critical thinking assessed by the CCTDI is as crucial as the requisite skills evaluated by the CCTST.[23] A student may possess strong critical thinking skills, but if the student is not inclined to use those skills, his or her full problem-solving potential will not be realized. Furthermore, the disposition towards critical examination of clinical problems, as opposed to facing problems emotionally or otherwise, is also very beneficial in the patient care setting. The results of this study suggest the preadmission assessment of applicants' critical thinking skills and their disposition toward critical thinking by admissions committees can be valuable in predicting applicants' future potential not only as a successful students in the classroom, but also as a competent practitioners.

At least 2 limitations of this study must be stated. First, it is difficult to adequately define and assess performance in a pharmacy practice setting. Our school uses a standardized grade sheet for the professional experience program clerkships, but the variety of practice sites and preceptors used in the fourth professional year can results in a lack of standardization of grades. For example, a previous study showed a significant relationship between PCAT scores and grades for fourth professional year experiential rotations.[18] We did not find this relationship. This highlights the difficulty of assessing performance in a pharmacy practice setting. Often, performance assessment varies from preceptor to preceptor, and perhaps between schools of pharmacy.

A second limitation is that this investigation used a convenience sample taken from one private school of pharmacy. Therefore, it may be difficult to generalize the results of this study to all other schools of pharmacy. Since the school graduated its first class in 2000, the sample size for this study was relatively small. However, future classes will be incorporated into the analysis as the data become available.

CONCLUSIONS

In this study, 2 traditional predictors, PCAT and essay, along with 2 nontraditional predictors, CCTDI and CCTST, were shown to be significant predictors of overall success in our Doctor of Pharmacy curriculum. The only traditional predictor of success in classroom-based courses was the PCAT score. The CCTDI, an indicator not often used in schools of pharmacy, also was shown to contribute significantly to success of students in classroom courses. However, the CCTST was the only examined indicator shown to be a significant predictor of the clerkship performance of our pharmacy students. Although more studies examining the predictive power of the nontraditional indicators of CCTDI and CCTST are needed, the present investigation is a preliminary step in validating the usefulness of these indicators of pharmacy students' performance. Therefore, these 2 valid and reliable instruments may be viable options for schools of pharmacy attempting to assess applicants' potential for future performance in both the classroom and the professional practice setting.

ACKNOWLEDGEMENTS

Presented in part at the annual meeting of the American Association of Colleges of Pharmacy, Kansas City, Mo, July 2002.

REFERENCES

1. Munson JW, Bourne DWA. Pharmacy college admission test (PCAT) as a predictor of academic success. *Am J Pharm Educ*. 1976;40:237-9.

2. Kotzan JA, Entrekin DN. Validity comparison of PCAT and SAT prediction of first-year GPA. *Am J Pharm Educ*. 1977;41:4-7.

3. Liao WC, Adams JP. Methodology for the prediction of pharmacy student academic success. I: preliminary aspects. *Am J Pharm Educ*. 1977;41:124-7.

4. Popovich NG, Grieshaber LD, Losey MM, Brown CH. An evaluation of the PCAT examination based academic performance. *Am J Pharm Educ*. 1977;41:128-32.

5. Lowenthal W, Wergin J, Smith HL. Predictors of success in pharmacy school: PCAT versus other admission criteria. *Am J Pharm Educ*. 1977;41:267-9.

6. Munson JW, Bourne DWA. Pharmacy college admission test (PCAT) as a predictor of academic success. II: a progress report. *Am J Pharm Educ*. 1977;41:272-4.

7. Jacoby KE, Plaxco WB, Kjerulff K, Weinert AB. The use of demographic background variables as predictors of success in pharmacy school. *Am J Pharm Educ*. 1978;42:4-7.

8. Torosian G, Marks RG, Hanna DW, Lepore RH. An analysis of admission criteria. *Am J Pharm Educ*. 1978;42:7-10.

9. Lowenthal W, Wergin J, Smith HL. Correlation of a biopharmaceutics grade and calculation scores in pharmacy school and arithmetic skills and mathematical reasoning subscores in

the pharmacy college admission test. *Am J Pharm Educ*. 1978;42:26-8.

10. Lowenthal W, Wergin JF. Relationship among student preadmission characteristics, NABPLEX scores, and academic performance during later years in pharmacy school. *Am J Pharm Educ*. 1979;43:7-11.

11. Palmieri A. Multivariate prediction of academic success of transfer students. II: evaluation of the predictor equations. *Am J Pharm Educ*. 1979;43:110-1.

12. Lowenthal W. Relationships among student admission characteristics, licensing examinations and didactic performance: comparison of three graduating classes. *Am J Pharm Educ*. 1981;45:132-9.

13. Friedman CB, Lage G, Norwood J, Stewart J. Predictive validity of the pharmacy college admission test. *Am J Pharm Educ*. 1987;51:288-91.

14. Bandalos DL, Sedlacek WE. Predicting success of pharmacy students using traditional and nontraditional measures by race. *Am J Pharm Educ*. 1989;53:145-8.

15. Lowenthal W, Meth H. Myer-Briggs type inventory personality preferences and didactic performance. *Am J Pharm Educ*. 1989;53:226-8..

16. Charupatanapong N, McCormick WC, Rascati KL. Predicting academic performance of pharmacy students: demographic comparisons. *Am J Pharm Educ*. 1994;58:262-8.

17. Chisholm MA, Cobb HH, Kotzan JA. Significant factors for predicting academic success of first-year pharmacy students. *Am J Pharm Educ*. 1995;59:364-70.

18. Allen DD, Bond CA. Prepharmacy indicators of success in pharmacy school: grade point averages, pharmacy college admission test, communication abilities, and critical thinking skills. *Pharmacotherapy*. 2001;21:842-9.

19. Hardigan PC, Lai LL, Arneson D, Robeson A. Significance of didactic merit, test scores, interviews and the admissions process: a case study. *Am J Pharm Educ*. 2001;65:40-3.

20. Kelley KA, Secnik K, Boye ME. An evaluation of the pharmacy college admissions test as a tool for pharmacy college admissions committees. *Am J Pharm Educ*. 2001;65:225-30.

21. American Association of Colleges of Pharmacy: Commission to Implement Change. Papers from the Commission to Implement Change in Pharmaceutical Education. Background Paper I: What is the Mission of Pharmaceutical Education? *Am J Pharm Educ*. 1993;57:374-6.

22. Welkowitz J, Even RB, Cohen J. *Introductory Statistics for the Behavioral Sciences*. third ed. New York, NY: Academic Press;1982:222-4, 364.

23. Facione PA. The disposition towards critical thinking: its character, measurement, and relationship to critical thinking skill. *J Gen Educ*. 1995;44:1-25.