GPHE 129805—24/8/2005——163473

Pharmacy Education, 2005; 5(3): 1–4

Early indicators of success in a pharmacy curriculum: The role of pre-professional science and mathematics courses

ROBERT T. CROW, CLAUDE J. GAEBELEIN, & MONA PATEL

St. Louis College of Pharmacy, 4588 Parkview Place, Saint Louis, MO 63110, USA

Q1

Abstract

This study identified courses in the pre-professional portion of the curriculum at the St. Louis College of Pharmacy that predicted success in the professional pharmacy curriculum, as measured by their impact on both cumulative grade point average (GPA) for their pre-professional work as well as their GPA before entering clinical externships. Transcripts of the class that started their pre-professional coursework in 1997 at the St. Louis College of Pharmacy underwent multiple regression modeling using SPSS software to analyze the effect of pre-professional science and math courses on pre-professional and pre-clinical academic performance. The basic math and science skills taught in general chemistry, biology, physiology, physics and organic chemistry had the strongest correlation with pre-professional success. Successful entry into the externship phase of the pharmacy curriculum depended primarily on biology, organic chemistry and physiology.

Keywords: *Assessment, academic performance, pre-pharmacy students, pharmacy students, grade point average, statistical significance*

Introduction

The need for predictors of academic success in the pharmacy curriculum has been a topic of interest to pharmacy schools for many years, with their importance having recently been addressed by the American Council on Pharmaceutical Education (American Council on Pharmaceutical Education, 1997). There have been numerous studies on this topic in the past, the majority of which have focused on grade point average (GPA) and standardized tests, such as the Pharmacy College Admissions Test (PCAT; Kotzan and Entrekin, 1977; Friedman et al., 1987; Thomas and Draugalis, 2002). Recent studies have included critical thinking skills, as measured by the California Critical Thinking Skills Test, as well (Allen and Bond, 2001; Kidd and Latif, 2003). Other studies have looked at, among the other variables, study strategies and time management (Sansgiry et al., 2004) and goal-efficacy (Carroll and Garavalia, 2004).

With the significance of the PCAT and cumulative pre-professional GPA firmly established, several studies have further examined the effect of individual courses and specific math and science sequences for their contribution to overall success in the pharmacy curriculum (Jacoby et al., 1978; Cox and Teat, 1991; Chisolm et al., 1995; Hardigan et al., 2001). These types of indicators are, however, difficult to assess, due in large part to the heterogeneity of the matriculating students; i.e. since most pharmacy schools admit students from many different institutions, there can be substantial differences in the level of preparedness of students for the professional curriculum. Indeed, these differences are the fundamental reason why standardized tests exist. In addition, overall pre-professional GPA usually contains or is even inflated by courses that do not necessarily measure a student's ability to succeed in professional pharmacy courses like medicinal chemistry or therapeutics. Hence, there is a need for a more rigorous examination of the association of the pre-professional curriculum to the

Correspondence: R.T. Crow, St. Louis College of Pharmacy, 4588 Parkview Place, Saint Louis, MO 63110, USA. Tel: 1-314-446-8470. Fax: 1-314-446-8304. E-mail: rcrow@stlcop.edu

ISSN 1560-2214 print/ISSN 1477-2701 online © 2005 Taylor & Francis
DOI: 10.1080/15602210500298224

successful completion of the professional pharmacy program.

The St. Louis College of Pharmacy (StLCOP), established in 1864, is an independent educational institution that matriculates high school graduates into a 2-year pre-professional program prior to entry into a 4-year professional course of study (Table I). Current academic policy requires all students to meet minimum GPA requirements in order to qualify for entry into the professional program. That GPA, however, is composed of many classes (Table I), some of which might be more important indicators of success in the professional program than others. In addition, the inherent homogeneity of the pre-professional experiences of StLCOP students makes them ideal subjects for studying the association between pre-professional academic performance and successful attainment of the Pharm. D. degree. Specifically, the experience of all students in each class is nearly identical; therefore, each grade in each course has minimal variation in terms of the material covered, difficulty, grading, etc.

The present paper assesses the association between performance in individual pre-professional courses and overall success in both the pre-professional curriculum as a whole and the pre-clinical professional curriculum. This was accomplished in two steps. First, a multiple regression model was used to select those pre-professional science and mathematics courses that were related to pre-pharmacy GPA. Those same courses were then evaluated with respect to their association with the cumulative GPA at the end of the pre-clinical professional curriculum. Special attention was paid to studying these variables free form the contaminating influence of intercorrelations among the predictor variables (see below).

Materials and methods

The Institutional Review Board of the StLCOP, which monitors all research involving human subjects, approved this study, assuring confidentiality.

The final grades of all courses required to complete both the pre-professional and professional curriculum for the 125 students entering StLCOP in 1997 were obtained from the Registrar of the College. This group recently completed their studies at StLCOP, and contained a large pool of students ($n = 78$ or 62.4%) who successfully completed degree requirements (either a B.S. or a Pharm. D.; see Table I). Letter grades were converted to the following numerical equivalents: A = 4.0, A − = 3.7, B + = 3.3, B = 3.0, B − = 2.7, C + = 2.3, C = 2.0, C − = 1.7, D + = 1.3, D = 1.0, D − = 0.7, and F = 0. Data

Table I. Required Courses at the St. Louis College of Pharmacy in 1997.

Course (credits)	Course (credits)
First Pre-professional Year	Second Pre-professional Year
Biology I & II (2 + 3)	Anatomy (3)
Calculus (3)	Cultural Heritage I & II (3 + 3)
Composition (3 + 3)	Organic Chemistry I (4 + 4)
General Chemistry I & II (4 + 4)	OTC (2)
Seminar (1)	Pharmaceutics I (2)
Electives (6)	Physiology I (4)
	Physics I (4)
	Electives (6)
Year 1	*Year 2*
Biochemistry (4)	Biostatistics (3)
Communications (3)	Immunology (2)
Health Care Systems Management (3)	Medicinal Chemistry I & II (4 + 3)
Microbiology (4)	Pharmaceutics III & IV(2 + 2)
Pathophysiology (3)	Pharmacology I & II (3 + 4)
Pharmaceutics II & III (2 + 3)	Therapeutics I & II (3 + 2)
Pharmacy Management (4)	Electives (6)
Physiology II (3)	
Electives (6)	
Year 3	*Year 4*
Clinical Pharmaceutics (3; Pharm.D. only)	Pharm D. Externships (32)
Drug Information (2)	Pharmacy Practice Seminar (2)
Jurisprudence (2)	
Pharmacy Practice (4)	
Therapeutics III (5)	
Therapeutics IV(6; Pharm. D. only)	
B.S. Externships (12)	
Electives (7-11; depending on degree)	

Two pre-professional years are followed by four professional years.

from remediated courses was not included in the analysis.

Two multiple regression models were used to quantify the relationship of basic science and mathematics courses to two separate cumulative GPAs. The first model used science and mathematics courses completed in the pre-professional years (i.e. general chemistry 1 & 2, biology 1 & 2, calculus, pharmaceutical calculations, organic chemistry 1 & 2, anatomy, physiology 1, and physics) to describe the cumulative GPA for the pre-professional program. The second multiple regression analysis explored the relationship of the science and mathematics courses selected in the previous analysis to the cumulative GPA at the end of the second professional year (Table I). This particular GPA was chosen to represent the cumulative professional GPA because it is at this point that the B. S. and Pharm. D. course requirements begin to diverge and require different courses before entering externships. The regression equations were calculated using SPSS (Release 12.0), with an α set at 0.05.

In addition to evaluating the basic fit of the model, the relationship of the independent variables to each other was examined using tolerance and partial correlation statistics. Tolerance measures intercorrelation among predictor variables, with lower values indicating a high degree of intercorrelation. Partial correlation coefficients (r_p) indicate the relation of a predictor to a dependent variable independent of their relationship to a common third variable. For example, the r_p of organic chemistry 2 with GPA is independent of correlations with organic chemistry 1 and GPA.

Results

Table II displays those pre-professional science and math courses that contributed significantly to the pre-professional GPA. The overall model included six predictors (general chemistry 1 & 2, biology 2, organic chemistry 2, physiology 1, and physics) that were associated with the final pre-professional GPA. The model fit exceeded 97% ($R^2 = 0.974$ and $R^2_{\text{adjusted}} = 0.949$, $(F_{6,37}) = 114.5$, $MS_e = 0.009$, $p < 0.001$). Tolerance results suggested little intercorrelation among the predictor variables. The partial correlation data (r_p) suggested that all variables were significantly related to the dependent variable.

Table III displays the ability of the independent variables defined in the first analysis to predict the professional GPA (completion of the second professional year). The overall model fit, although statistically significant, was reduced compared to the model described above ($R^2 = 0.911$ and $R^2_{\text{adjusted}} = 0.806$, $(F6,37) = 34.3$, $MS_e = 0.022$, $p < 0.001$). This was reflected in the r_p lower values of these predictors. Organic 2, physiology 1, and biology 2 did continue to make statistically significant contributions to describing the cumulative

Table II. Results of stepwise multiple regression analysis identifying courses associated with pre-professional GPA.

	Unstandardized coefficients					
Model	*B*	Standardized error	*T*	Significant	Partial correlation (r_p)	Tolerance
(Constant)	1.052	0.084	12.634	0.000		
Physics	0.157	0.033	4.750	0.000	0.615	0.399
Organic 2	0.104	0.030	3.410	0.002	0.489	0.338
Bio 2	0.094	0.031	3.065	0.004	0.450	0.508
Chem 1	0.122	0.035	3.513	0.001	0.500	0.491
Physio 1	0.131	0.034	3.831	0.000	0.533	0.434
Chem 2	0.112	0.035	3.191	0.003	0.465	0.352

Excluded variables are anatomy, biology 1, calculus, organic chemistry 1, and pharmaceutical calculations.

Table III. Results of stepwise multiple regression analysis using courses important in predicting pre-professional GPA to describe professional GPA scores.

	Unstandardized coefficients					
Model	*B*	Standardized error	*T*	Significant	Partial correlation (r_p)	Tolerance
(Constant)	1.325	0.132	10.052	0.000		
Chem 2	0.055	0.048	1.135	0.263	0.173	0.387
Physics	0.063	0.048	1.326	0.192	0.200	0.455
Physio 1	0.193	0.047	4.090	0.000	0.534	0.476
Organic 2	0.109	0.039	2.762	0.008	0.392	0.453
Bio 2	0.088	0.040	2.213	0.032	0.323	0.590
Chem 1	0.080	0.054	1.482	0.146	0.223	0.532

Abbreviations are the same as those in Table II.

professional GPA, while the remaining courses identified in the first model became less relevant.

Discussion

The model outlined in Table II shows that six courses (biology 2, general chemistry 1 & 2, organic chemistry 2, physiology 1, and physics) were valuable predictors of pre-professional success. These courses are strong predictors of success even though they only constitute approximately 36% of the credits required in the pre-professional part of the curriculum (23 of 64 credits; Table I). This may be because they incorporate the basic computational and scientific skills that are important in the practice of pharmacy. This information is a valuable addition to the resources used by academic advisors of pre-pharmacy students.

Success in basic science courses was an essential component of success in the pre-professional curriculum. The impact of basic science courses on cumulative professional GPA, however, is less clear. This pattern may be attributed to the incorporation of the fundamental principles of the basic science courses into later, more applied professional courses. Such a transition may diminish the unique contribution of the basic science courses to the professional pharmacy curriculum. Thus, the data suggest that, in addition to academic success, the ability and facility to integrate basic science principles into the professional pharmacy curriculum may constitute a skill fundamental to pharmacy education.

As above, it is worth noting that the courses listed in Table III are strong predictors of success in the professional curriculum even though they now represent only about 17% of the pre-professional coursework (11 of 64 credits; Table I). Table I shows a pre-professional GPA in both modeling experiments that is dominated by other courses (e.g. composition, electives, etc.). The results in Table III clearly indicate that pre-professional GPA alone could be woefully inadequate in identifying qualified applicants to professional pharmacy programs, and that particular attention should be paid to the specific courses indicated above.

Finally, the use of tolerance (i.e. looking at the amount of intercorrelation among variables) and the use of partial correlation coefficients (r_p) add additional value to this particular study. The specific ability of these functions to identify and establish the independent influence of these courses on student success should aid both admissions officials and academic progression administrators invaluable assistance in identifying students who will be successful in the pharmacy curriculum.

Acknowledgements

This work was generously supported by a grant from the Research Incentive Fund at the St. Louis College of Pharmacy.

References

Allen, D. D., & Bond, C. A. (2001). Pre-pharmacy predictors of success in pharmacy school: Grade point averages, Pharmacy College Admissions Test, communication abilities, and critical thinking skills. *Pharmacotherapy*, *21*, 842–849.

American Council on Pharmaceutical Education. Accreditation standards and guidelines for the professional program in pharmacy leading to the Doctor of Pharmacy Degree, Chicago, IL (1997)

Carroll, C. A., & Garavalia, L. S. (2004). article 88 Factors contributing to the academic achievement of pharmacy students: Use of the goal-efficacy framework. *American Journal of Pharmaceutical Education*, *68*.

Chisolm, M. A., Cobb, H. H., & Kotzan, J. A. (1995). Significant factors predicting academic success of first-year pharmacy students. *American Journal of Pharmaceutical Education*, *59*, 364–370.

Cox, F. M., & Teat, D. W. (1991). Predictors of academic performance in a Doctor of Pharmacy training program. *Journal of Pharmacy Teaching*, *2*, 45–58.

Friedman, C. B., Lage, G., Norwood, G. J., & Stewart, J. (1987). Predictive validity of the Pharmacy College Admission Test. *American Journal of Pharmaceutical Education*, *51*, 288–291.

Hardigan, P. C., Lai, L., Arneson, D., & Robeson, A. (2001). Significance of academic merit, test scores, interviews, and the admissions process: A case study. *American Journal of Pharmaceutical Education*, *65*, 40–44.

Jacoby, K. E., Plaxco, W. B., Kjerluff, K., & Weinert, A. B. (1978). The use of demographic and background variables as predictors of success in pharmacy school. *American Journal of Pharmaceutical Education*, *42*, 4–7.

Kidd, R. S., & Latif, D. A. (2003). article 109 Traditional and novel predictors of classroom and clerkship success of pharmacy students. *American Journal of Pharmaceutical Education*, *67*.

Kotzan, J. A., & Entrekin, D. N. (1977). Validity comparison of PCAT and SAT in the prediction of first year GPA. *American Journal of Pharmaceutical Education*, *41*, 12–17.

Sansgiry, S. S., Kawatkar, A. A., Dutta, A. P., & Bhosle, M. J. (2004). article 103 Predictors of academic performance at two universities: The effects of academic progression. *American Journal of Pharmaceutical Education*, *68*.

Thomas, M. C., & Draugalis, J. R. (2002). Utility of the Pharmacy College Admissions Test (PCAT): Implications for admissions committees. *American Journal of Pharmaceutical Education*, *66*, 47–51.

Author Queries

JOB NUMBER: MS 129805—
JOURNAL: GPHE

Q1 Kindly provide the article history.