

The Predictive Value of a School of Origin Variable in Pharmacy Student Academic Performance

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ABSTRACT. This project evaluated the predictive capabilities of a school of origin variable over and above the predictive capabilities of a model including pre-pharmacy math/science GPA, PCAT, and prior degree variables. Evaluating 6 years of pharmacy student admission and progression data from 1997 to 2002, the project explored a variable that designated the location where a majority of the pre-pharmacy course work was completed, either a 2-year or 4-year school. The regression models found that a school of origin variable contributed significantly to the predictive model of GPA and PCAT and accounted for more variance than prior degree in the prediction of first-semester and first-year pharmacy-student GPA. Defining a school of origin variable based upon the location of completion of the majority of pre-pharmacy course work aids in the prediction of first-year pharmacy students' academic perfor-

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INTRODUCTION

The admission process is the first opportunity to evaluate students' potential to successfully complete an academic program. It also can be used to select those who already possess some level of the abilities necessary to practice pharmacy. The admission process uses students' past performance to predict future academic performance. Identification and retention of high quality students is important in the development of an academic program that produces quality pharmacists to meet the needs of the profession. This need is heightened by the shortage of pharmacists, the political and environmental pressures to increase enrollment, and the costs of remediation and attrition to the institution. Traditionally, schools of pharmacy set minimum criteria for potential candidates to select the most qualified applicants. Social scientists have evaluated a myriad of variables over the years for their ability to explain and predict students' academic success (1-3). These analyses have been conducted using various student groups, including those in professional programs such as medicine, optometry, and pharmacy. Some of the difficulty in predicting academic performance results from determining which variables should be used as predictors, which variables should be used to represent successful academic performance, and how to operationalize and assess those variables.

Over time, a number of quantitative and demographic variables have been used to predict academic performance (1-3). As evidenced by the research cited within this paper from the last 30 years, grade point averages (GPAs) and Pharmacy College Admission Test (PCAT) scores are the most common. The PCAT is a standardized admission test developed and administered by The Psychological Corporation for many years and now is administered by Harcourt. Standardized tests, such as the PCAT, are useful in the prediction of academic performance because they use population norms to compare the preparedness of appli-

cants. The PCAT measures topic areas that are relevant to schools of pharmacy. However, the research conducted to explore the usefulness of GPA and the PCAT in predicting academic performance has defined and used them differently, and schools of pharmacy have used them differently in the admission process (1-6). These issues are further confounded by the differences in the population studied, differences in student educational backgrounds, and policy differences between schools. These differences make it difficult to evaluate the generalizability of the research.

A review of the literature also reveals that many variables outside of the PCAT and pre-pharmacy GPA have been used in an attempt to predict pharmacy students' performance. These variables have included other tests and standardized measures such as the SAT; demographic variables such as race, gender, and age; and previous education measures such as school of origin and prior four-year degree attainment. In most cases, generalizability is difficult to obtain because the analyses were run on a limited sample. In addition, the variables used have issues that confound their ability to predict academic performance accurately.

As mentioned previously, many schools of pharmacy rely on GPA and PCAT as key admission criteria (4). The PCAT is a standardized measure and the GPA is not. The GPA varies based on many factors. This variability can be due to instructor, school of origin, course content, course difficulty, and years since completing the course work, among other factors. Because this key predictor of admission and progression differs across institutions, it may be necessary to delineate GPA based upon school of origin. A reasonable place for an initial dividing line is between two-year institutions and four-year institutions.

The identification of additional predictors that can be used to recognize both successful and at-risk students is important to the admissions process. This project reviewed the literature, identified potential variables contributing to academic performance analyses, and, through the examination of secondary data, explored their viability. The institution attended by students prior to their entry into pharmacy school has been identified as potentially having a relationship with pharmacy school academic performance. The analysis centers on the questions, "What is the value of school of origin in the prediction of academic performance?", "What influence does school of origin have on the traditional variables used to predict academic progression?" "How useful is the definition of school of origin, 2-year (institutions that do not offer baccalaureate degrees) and 4-year (institutions that offer baccalaureate degrees), based on math science GPA?"

Prediction of the academic progression of pharmacy students has been an area of scientific inquiry for well over 30 years. During that time, measures such as the PCAT have been developed and adopted widely. In addition to the PCAT, many other variables have been developed and/or assessed for their added usefulness in predicting academic performance. In these analyses, 2 predictors have been the most consistent: pre-pharmacy GPA and PCAT.

Quantitative Variables—GPA and PCAT

The PCAT is a standardized test developed to assess students' ability on several components, including verbal ability, reading comprehension, biology, chemistry, quantitative ability, arithmetic skills, and mathematical reasoning. PCAT scores are reported as component scores and total scores (5). These scores are reported both as "scaled" scores and percentile scores. In the published literature, all forms of PCAT scores have been used with varied success in prediction, including individual component scores (6). Previous research also has varied in its use of pre-pharmacy GPA. The GPAs used have been calculated both from all pre-requisite course work and from science/math course work. In addition to this variety, there are influences that reduce the consistency of GPA, such as instructor and school of origin.

The most common evaluation of admission and progression criteria has centered on quantitative measures such as GPA and PCAT. This is outlined in the Appendix which summarizes research to date on pharmacy admission and progression prediction. On average, the 2 variables have accounted for roughly 40% of the variance in academic performance. The use of these 2 predictor variables has been consistent over the last 25 years of pharmacy education.

Kuncel et al. conducted a meta-analysis of research to date on academic performance and found similar results (7). The PCAT score and the pre-pharmacy GPA were valid predictors of pharmacy student academic performance at all years of progression. Their study evaluated 20 studies and found that the PCAT and pre-pharmacy GPA accounted for variances in first-year GPA between 32% and 69% for the PCAT and 35% and 65% for pre-pharmacy GPA (7).

School of Origin Variables

Relative to PCAT scores and GPA, it appears that demographic variables have demonstrated little or no role as predictors of academic per-

formance in the literature to date. However, an interesting finding is the applicability of a source/origin variable. Torosian and colleagues found that the GPA of students from “higher quality” community colleges correlated highly with pharmacy school performance (8). This is consistent with the findings of Hall and Bailey, Jacoby et al., and Bandalos and Sedlacek and with the prior-degree research of Chisholm et al. (4, 9-12).

Jacoby found that an origin variable defined by using a quality rating of the transfer school accounted for variance in academic progression ranging between 6% and 16%, depending on the class under examination (11). Similarly, Torosian found that subjective quality ratings of schools of origin aided in the prediction of academic progression (8). Bandalos and Sedlacek found that a source (origin) variable that was a qualitative assessment of the feeder institution aided only slightly in prediction (8). Palmieri’s final progression model included type of transfer school (12). Chisolm et al. found that, in addition to pre-pharmacy science GPA, the attainment of a prior four-year degree was a positive predictor of academic success (4). Hall and Bailey examined the traditional variables of GPA and MCAT for first-year medical school performance but added a college selectivity variable which ranked undergraduate feeder institutions based on SAT performance (11).

It has been noted both anecdotally and in the literature that some students transferring from a two-year institution to a four-year institution encounter “transfer shock” and academically suffer during their junior or third year (13). Glass and Harrington found that although the second-year GPAs of transfer students from their schools of origin were higher than those of resident university students, the GPAs of community college transfer students were significantly lower than those of resident students in the third year of course work (13). It also has been noted that the percentage of transfer students graduating on schedule was lower than the percentage of resident students graduating on schedule (13).

Houglum et al. evaluated retrospective data to determine predictors of academic success and failure (14). Academic success was based upon first-year pharmacy curricula GPA and academic failure was determined by those students assigned to academic probation. Predictors of academic failure included gender, ACT score and organic chemistry grade. Predictors of academic success included ACT score, organic chemistry grade, prior degree, and having transferred into South Dakota State University (14).

The admission formula used by schools of pharmacy may give positive weight to applications received from an institution's current students over those received from other schools. This adjustment is intended to account for educational differences based on school of origin and favors the students currently in residence.

Research Questions and Significance

Outside of pre-pharmacy GPA and PCAT, it has been difficult for research to consistently identify significant contributors to the prediction of the academic progression of pharmacy students. While many additional variables have been explored, historically these variables have not been demonstrated to be significant consistently. This may be due in part to small sample sizes. It may be that predictive models based on more years of data may find more stable predictors.

One such variable of interest that has appeared in the published literature has been the school of origin. However, this predictor variable has been defined differently in multiple studies. Given such differences, it is important to determine a practical operationalization of school of origin that is not based on a subjective assessment. Once appropriately defined, such a variable may be able to predict differences in the academic performance of pharmacy students and thereby contribute to the current progression models used by schools of pharmacy.

The addition and strict characterization of the variables will aid in the development of a model beyond GPA and PCAT that will enable schools to identify at-risk students sooner and to attend to their needs as deemed necessary. Because two-year transfer students may experience a "transfer shock" or have socialization issues, these analyses will use the dependent variable of GPA at the end of the first professional semester and the first professional year.

School of origin has demonstrated a relationship with academic performance in previous research. This research assesses the ability of school of origin to contribute to the prediction of academic performance. In addition, differences between students' scores and grades were assessed based on their school of origin classification. This led to hypotheses 1 through 3.

- H₁: School of origin will contribute significantly to the variance accounted for by a regression model based on PCAT and pre-pharmacy GPA in the prediction of first semester and first year pharmacy school GPA.

- H₂: Four-year school transfer students will score higher on the PCAT when compared to the two-year school transfer students.
- H₃: There is a difference in pre-pharmacy GPA between groups defined by school of origin.

METHODS

This project used the in-house data collected at the time of admission and the database created for the monitoring of student progression at the University of Mississippi School of Pharmacy. A sample of 6 consecutive years' worth of incoming student data (1997 to 2002 inclusive) was drawn from the information management system resulting in 405 individual student records in the database.

The University of Mississippi School of Pharmacy has an early assurance program which allows for the admission of freshman-level students into the pharmacy curriculum. These students apply to the school through a different process, and the course work sequence for their progression is different from that followed by students admitted through the traditional mechanism. As a result, these early assurance students were excluded from the analysis.

Because this study explored the impact, if any, of a school of origin variable, first-semester pharmacy GPA was used as a dependent variable. In addition, the first-year pharmacy GPA was used to analyze a more stable measure of performance. Previous research in academic performance has used these variables. An additional benefit of these dependent measures is the ability to make comparisons to previously conducted research. These variables served as the dependent variables for the hierarchical regression equations. Independent variables extracted from the records and database included pre-pharmacy math/science course GPA, transfer school(s) of origin, prior degree attainment, and PCAT (raw and percentile) scores. While collected in the database, demographic variables such as age, race and sex were not included in this study. Primarily, the decision to exclude the demographic variables was due to the lack of viability of such variables in the selection of students for admission.

Variable Definition

For the purposes of this research, school of origin was defined as follows. Community colleges and junior colleges were two-year institu-

tions providing no degree higher than an associate-level degree or a nonterminal degree. Four-year institutions were colleges and universities that provide a baccalaureate-level degree or higher. The school of origin variable consisted of 3 nominal categories: 2-year, 2 + 4-year, and 4-year. Dummy coding procedures were used prior to analysis.

School of origin was defined according to the required pre-pharmacy math/science courses. The school of origin was identified as the institution at which the applicant completed greater than 75% of the required pre-pharmacy math/science courses. These courses included 8 hours of biological science, 16 hours of chemistry, 8 hours of physics, and 3 hours of mathematics (calculus). The determination of school of origin was based on all attempts at the listed course work that were included in the computation of pre-pharmacy math/science GPA at the school. For example, a student's record may look like Table 1.

In this situation, the student will have taken required pre-pharmacy coursework at both a 2-year and a 4-year institution. Because 12 out of a total of 35 pre-pharmacy math/science courses were taken at a 2-year institution, the student described in Table 1 would be classified as a 2 + 4-year student (35% of the total hours).

When comparing students who had completed 75% of their math/science pre-pharmacy course work at the University of Mississippi to students who had completed 75% of their math/science pre-pharmacy course work at other 4-year institutions, no differences were found in pre-pharmacy math/science GPA, PCAT scores (raw and percentile), first-semester pharmacy GPA, or first-year pharmacy GPA. Therefore, students who had attended the University of Mississippi and other four-year institutions were grouped in the analyses. In addition to the school of origin designation, a separate variable of prior degree was measured using two nominal categories, prior four-year degree obtained and no degree obtained.

Because it was integral to the operationalization of school of origin, the pre-pharmacy GPA used in this study was the pre-pharmacy math/

TABLE 1. Sample Student Hour Distribution Upon Admission

School type attended	Biology Hours	Chemistry Hours	Physics Hours	Calculus Hours	Total
Two-year	4	4	4		12
Four-Year	4	12	4	3	23
Student's total hours	8	16	8	3	35

science GPA comprised of the aforementioned course hours. This definition allowed for other institutions to replicate this study and is in line with the work of Chisholm et al., who used a math/science GPA (15). The PCAT scores used in the analysis were the highest scores attained within the 12 months preceding the application deadline. This is the standard admission policy at the University of Mississippi School of Pharmacy and was used for this study. Pre-pharmacy math/science GPA was used to categorize the schools for two reasons: first, it should be more easily evaluated by other schools of pharmacy, and second, the majority of first-year pharmacy course work at the University of Mississippi School of Pharmacy is comprised of math/science-based course work.

Analysis

It was apparent from the literature review of pharmacy-related studies that the mostly commonly employed statistical technique is multiple regression analysis and this is consistent with other disciplines (16,17,18). Additionally, multiple regression was the method of choice for this research for its interpretability, and for ease in direct comparisons to the majority of the research performed in this arena. Pre-pharmacy GPA and PCAT scores have been shown to be the most consistent predictors of academic performance and are accepted widely for use in the admission process. Any new variables must contribute to the prediction of academic performance above and beyond the model consisting of pre-pharmacy GPA and PCAT. The most appropriate analytic strategy for such a situation is hierarchical multiple regression.

The analysis was performed using SPSS REGRESSION (19). The goal of the analysis was to develop an improved, stable model for prediction of academic performance. In this context, it was important to discern and explore issues with multicollinearity before promoting the predictive ability of one construct over another. To this end, the intercorrelations of all independent variables were explored. This analysis determined the amount of shared variance among the variables and the resulting impact on the stability of the beta coefficients.

The initial hierarchical regression model for the evaluation of the variables was built. Because they are the strongest predictors of academic performance, pre-pharmacy GPA and PCAT scores were entered into the hierarchical design first, then prior degree. Following their inclusion, each was analyzed for significance. Lastly, the school of origin variable was entered into the analysis. The incremental variance ac-

counted for in the multiple R^2 was analyzed for statistical significance at each of the steps. This method enabled the exploration of the incremental ability of the other variables to predict academic performance. Hypotheses 2 and 3 were analyzed using analysis of variance (ANOVA) and post-hoc tests. This study was conducted with the approval of the Institutional Review Board for the Protection of Human Subjects (IRB).

RESULTS

Sample Description

The 6 years of student data resulted in 405 unique cases, 173 were categorized as 2-year transfer students, 34 as 2 + 4 year transfer students, and 198 as 4-year transfer students. Fifty-five students had acquired prior degrees prior to attending pharmacy school. The data were assessed for differences based on class year prior to aggregate analyses. No differences were found based on year for the math/science pre-pharmacy GPA ($p > 0.05$). In the analysis of PCAT scores (raw and percentile) by year, only the 1997 and 2002 classes were found to differ significantly. Based on these results, the data were aggregated for analysis.

Six years of data provided between 57 and 83 students per year. The cases used represented only the first attempt at any of the required course work. Grades obtained following repetition of courses were not included in the analysis. The sample of students was the same for both the first-semester GPA and first-year GPA analyses. The breakdown of students by year is presented in Table 2. This provided a case to independent variable ratio of roughly 27 to 1. Thus, the final sample was more than adequate for the analyses.

Hypotheses Tests

Hypothesis 1 was analyzed using a hierarchical multiple regression model. In the base model, the traditional variables of pre-pharmacy

TABLE 2. Number of Students Per Academic Year

Year	1997	1998	1999	2000	2001	2002	Total
<i>n</i>	62	71	64	68	83	57	405
Mean Math/Science GPA	3.22	3.22	3.30	3.48	3.33	3.47	
Mean PCAT	201.06*	205.52	210.26	210.77	209.66	213.47*	

*Significantly different $p < 0.01$

math/science GPA and PCAT were entered first. Then, the school of origin variable was entered. Separate models were performed for first-semester GPA and first-year GPA.

Two dummy variables for the school of origin variable were added to the base model of GPA = pre-pharm MS GPA + PCAT. These variables compared the 2 + 4 year transfer students (SOO1) and 4-year transfer students (SOO2) to the 2-year transfer students base group.

School of origin significantly contributed to the variance accounted for by the base models ($p < 0.05$). The adjusted R^2 for the first-semester pharmacy GPA increased from 0.37 to 0.43. The adjusted R^2 for the first-year pharmacy GPA model increased similarly from 0.37 to 0.41. The variance contributed was the result of the four-year school of origin designation from the second dummy variable. The 4-year students had a first-semester pharmacy GPA 0.26 higher than 2-year transfer students (3.41 vs. 3.15) and had a first-year pharmacy GPA 0.21 (3.36 vs. 3.15) points higher (both significant at $p < .05$). The 2 + 4-year students had a first-semester pharmacy GPA 0.104 higher than 2-year transfer students and had a first-year pharmacy GPA 0.06 points higher (both non-significant at $p > .05$). The resulting coefficients for each model are shown in Tables 3 and 4.

Based on these results, Hypothesis 1 was supported. School of origin contributed significantly to the variance accounted for by a regression based on PCAT and pre-pharmacy GPA.

The impact of the school of origin variable also was assessed against a model consisting of pre-pharmacy math/science GPA, PCAT, and prior degree (baccalaureate or master's) status. Prior degree contributed significantly to the base model increasing R^2 of the models for the

TABLE 3. First Semester Pharmacy GPA Base Model + School of Origin

Model		Unstandardized	Standardized	<i>t</i>	Sig.
		Coefficients B	Coefficients Beta		
1	(Constant)	1.101		7.124	$p < 0.05$
	Pre-Pharmacy Math-Science GPA	.525	.486	11.598	$p < 0.05$
	PCAT Composite Score	6.760E-03	.303	7.245	$p < 0.05$
2	(Constant)	.792		5.007	$p < 0.05$
	Pre-Pharmacy Math-Science GPA	.606	.561	13.285	$p < 0.05$
	PCAT Composite Score	5.330E-03	.239	5.761	$p < 0.05$
	School of Origin Dummy Variables				
	SOO1 (Two-Four)	.104	.058	1.392	.165
	SOO2 (Four-Year)	.263	.262	5.931	$p < 0.05$

TABLE 4. First-Year Pharmacy GPA Base Model + School of Origin

Model		Unstandardized	Standardized	<i>t</i>	Sig.
		Coefficients	Coefficients		
		B	Beta		
1	(Constant)	1.285		9.214	<i>p</i> < 0.05
	Pre-Pharmacy Math-Science GPA	.472	.484	11.549	<i>p</i> < 0.05
	PCAT Composite Score	6.117E-03	.305	7.265	<i>p</i> < 0.05
2	(Constant)	1.038		7.211	<i>p</i> < 0.05
	Pre-Pharmacy Math-Science GPA	.538	.551	12.954	<i>p</i> < 0.05
	PCAT Composite Score	4.934E-03	.246	5.865	<i>p</i> < 0.05
	School of Origin Dummy Variables				
	SOO1 (Two-Four)	6.020E-02	.037	.883	.378
	SOO2 (Four-Year)	.216	.239	5.362	<i>p</i> < 0.05

first-semester pharmacy GPA and first-year pharmacy GPA. The variance accounted for by the base model in the first-semester and first-year GPA model was increased from R^2 of 0.37 to 0.38 with the inclusion of prior degree. The inclusion of the school of origin variable contributed significantly to the base + prior degree model for both first-semester pharmacy GPA and first-year pharmacy GPA increasing the R^2 from 0.38 to 0.43 for the first-semester GPA model and from 0.38 to 0.42 for the first-year GPA model ($p < 0.05$).

For both models, the four-year transfer variable for school of origin contributed significantly to the prediction of first-semester pharmacy GPA and first-year pharmacy GPA, over and above pre-pharmacy math/science GPA, PCAT, and prior degree status. The four-year transfer school of origin variable accounted for the variance contained within the prior degree variable, removing the significant contribution of prior degree in the final model. This adds further support for Hypothesis 1. The coefficients for the final models are shown in Tables 5 and 6.

The school of origin variable was based on where the majority of the pre-pharmacy math/science course work was completed and then dummy coded. The coefficients for the four-year transfer school of origin variable show that as the source of the pre-pharmacy course work changed from two-year schools to four-year schools, the first-semester pharmacy and first-year pharmacy GPAs increased. The analyses of school of origin were based on a significant majority premise. If 75% of the course work was performed at a 4-year institution, then that student was designated as a 4-year transfer.

To evaluate the appropriateness of this assumption, additional the regression analyses were performed; using a 50% cut score. In this case, if

TABLE 5. Coefficients First-Semester Pharmacy GPA Base Model + Prior Degree + School of Origin

Model		Unstandardized	Standardized	<i>t</i>	Sig.	
		Coefficients	Coefficients			
		B	Beta			
1	(Constant)	1.101		7.124	<i>p</i> < 0.05	
	Pre-Pharmacy Math-Science GPA	.525	.486	11.598	<i>p</i> < 0.05	
	PCAT Composite Score	6.760E-03	.303	7.245	<i>p</i> < 0.05	
2	(Constant)	1.044		6.735	<i>p</i> < 0.05	
	Pre-Pharmacy Math-Science GPA	.542	.501	11.926	<i>p</i> < 0.05	
	PCAT Composite Score	6.437E-03	.289	6.884	<i>p</i> < 0.05	
	Prior Degree	.153	.106	2.533	.012	
3	(Constant)	.776		4.904	<i>p</i> < 0.05	
	Pre-Pharmacy Math-Science GPA	.612	.566	13.385	<i>p</i> < 0.05	
	PCAT Composite Score	5.212E-03	.234	5.623	<i>p</i> < 0.05	
	Prior Degree	8.958E-02	.062	1.509	.132	
	School of Origin Dummy Variables					
		SOO1 (Two-Four)	9.274E-02	.052	1.233	.219
	SOO2 (Four-Year)	.249	.249	5.526	<i>p</i> < 0.05	

a student had completed more than 50% of the course work at a 4-year institution, then that student was designated as a 4-year transfer. Otherwise, the student was designated as a two-year transfer. The regression models for the 50% cut point were similar to the previous models. The adjusted R^2 for the first-semester pharmacy GPA model of pre-pharmacy math/science GPA, PCAT, and school of origin was 0.417. The R^2 for the first-year model was 0.407.

Hypothesis 2 proposed a comparison of PCAT scores for students transferring from two-year colleges and students transferring from four-year institutions. This was tested using ANOVA. The post-hoc analysis was conducted using Tamhane's T2 because the homogeneity of variance assumption was violated between these groups. The school of origin variable was a three-level variable and assessed score differences on the PCAT raw score. PCAT raw scores were used rather than percentile scores as recommended by Glass and Hopkins (20). Four-year transfer students scored higher on the PCAT than the two-year transfer students 212.32 vs. 204.57, $p < 0.05$, (Table 7). Two-four year transfer students did not differ from the four-year transfer students (209.38 vs. 212.31, $p > 0.05$). Therefore, Hypothesis 2 was supported.

Hypothesis 3 addressed the school of origin variable and its relationship to the pre-pharmacy math/science GPA variable. The ANOVA

TABLE 6. Coefficients First-Year Pharmacy GPA Base Model + Prior Degree + School of Origin

Model		Unstandardized	Standardized	<i>t</i>	Sig.	
		Coefficients	Coefficients			
		B	Beta			
1	(Constant)	1.285		9.214	<i>p</i> < 0.05	
	Pre-Pharmacy Math-Science GPA	.472	.484	11.549	<i>p</i> < 0.05	
	PCAT Composite Score	6.117E-03	.305	7.265	<i>p</i> < 0.05	
2	(Constant)	1.245		8.869	<i>p</i> < 0.05	
	Pre-Pharmacy Math-Science GPA	.484	.496	11.755	<i>p</i> < 0.05	
	PCAT Composite Score	5.891E-03	.293	6.957	<i>p</i> < 0.05	
	Prior Degree	.107	.082	1.957	.051	
3	(Constant)	1.028		7.127	<i>p</i> < 0.05	
	Pre-Pharmacy Math-Science GPA	.541	.555	12.995	<i>p</i> < 0.05	
	PCAT Composite Score	4.861E-03	.242	5.759	<i>p</i> < 0.05	
	Prior Degree	5.508E-02	.042	1.019	.309	
	School of Origin Dummy Variables					
		SOO1 (Two-Four)	5.305E-02	.033	.774	.439
	SOO2 (Four-Year)	.208	.230	5.056	<i>p</i> < 0.05	

TABLE 7. Mean PCAT Raw Score by School of Origin

	N	Mean PCAT Raw Score	Std. Deviation
Two-year	167	204.57	12.11
Two + four year	32	209.38	17.86
Four year	166	212.32	16.69

analysis showed that the pre-pharmacy math/science GPA was higher ($p < 0.05$) for transfer students from two-year schools (mean = 3.46) than for students who completed the pre-pharmacy math/science course work predominantly at a mixture of two-year and four-year schools (mean = 3.24) or predominantly at a four-year institution (mean = 3.23). Table 8 shows the results. Tamhane's T2 post-hoc test was used because the assumption of equal variances was violated ($p < 0.05$).

Thus, Hypothesis 3 was supported. Students who completed their pre-pharmacy math/science course work predominantly at a two-year institution had higher pre-pharmacy math/science GPAs than transfer students with a mixture of pre-pharmacy institutions (two-year and four-year) and transfer students from four-year institutions.

TABLE 8. Mean Pre-Pharmacy MSGPA by School of Origin

	N	Mean Pre-Pharmacy MSGPA	Std. Deviation
Two-year	173	3.46	0.42
Two + four year	34	3.24	0.44
Four year	170	3.23	0.46

DISCUSSION

This research expanded upon previous work in the field of the prediction of progression using admission criteria. This study explored a categorization of a school of origin variable that had been assessed qualitatively in the previous work. The implications of this work fall in line with the three hypotheses. The regression models for prediction of first-semester and first-year pharmacy GPAs showed that school of origin, defined by the predominant source of pre-pharmacy math/science course work, contributed significantly over and above the base model of pre-pharmacy math/science GPA and PCAT scores. In fact, this contribution to the variance accounted for by the model was over and above the variance contributed by prior degree attainment.

Although recent research has demonstrated prior degree as a significant predictor of academic performance, there may exist another metric that accounts for prior degree effects and the effects of school of origin (4). That is, it is the attendance at a four-year institution, regardless of degree attainment, that leads to improved performance. Indeed, the ability of school of origin to predict first-semester and first-year pharmacy GPAs is even more important in light of the fact that two-year transfer students have higher pre-pharmacy math/science GPAs than their four-year contemporaries and that students from four-year institutions performed better on the PCAT than students from two-year institutions.

This is not to imply that two-year institutions are not preparing students for pharmacy school. While that may be the case, a number of factors could contribute to the finding. First, there is a socialization process that is necessary upon transfer to a four-year school. There is an extensive community college system in Mississippi which enables students to complete the majority of their pre-pharmacy course work in the same region where they completed high school. Yet, to enter pharmacy school, they must move from that region to an unfamiliar one and adapt to their new surroundings. This is one of the reasons behind the “transfer shock” concept (12). Additionally, transfers from two-year institu-

tion may have attended a community college for financial reasons. The financial obligations are increased upon transfer to pharmacy school and may require a student to engage in outside employment to meet them. This also could contribute to the performance difference between students from different feeder schools. This four-year designation, therefore, contains multiple factors that could possibly explain the findings of the study, these include, and may not be limited to, the total coursework completed over the student's pre-pharmacy career, the degrees obtained (variance explained by prior degree was accounted for by the four-year designation), the type of degree obtained, the supportive services offered, the number of times specific coursework was repeated over the student's pre-pharmacy career, "transfer shock", and any other factors that make four-year institutions inherently different than two-year institutions. However, regardless of the reasons, this study found a link between academic performance and completion of pre-pharmacy course work at a four-year institution. This has implications for the identification of students with the potential for remediation.

This study is based upon six years of data. While this amount of data is significant, it is still limited to a single institution. The fact that this study is based on only one school limits the generalizability of the findings to schools outside this system. In addition, this study did not explore academic performance beyond the first year of pharmacy school. It is entirely possible that academic performance in later years or the acquisition of the pharmacy degree may be predicted by models that differ from the ones evaluated in this work.

It was not within the scope of this project to apply quality assessments or proximity measures to the school of origin variable. Such evaluations would differ by school and this study attempted to evaluate the role of the base school of origin variable in a manner that can be duplicated by other institutions. Other "feeder" schools may differ by quality, proximity, quantity, and performance and should be assessed separately. A multi-institutional evaluation of longitudinal data would provide more generalizable data than an analysis of a single institution's data, and could account for any regional differences in "feeder" institutions.

The goal of the resulting model is to accurately predict the performance of pharmacy students. In an environment where pharmacists are in high demand or schools are under pressure to graduate more pharmacists, where 70% of schools allow students to retake an academic year, and where pressures exist to graduate students who possess the abilities

necessary to be successful, it is important to increase the ability of pharmacy educators to admit students who are likely to be successful (21). It is also important to identify at-risk students prior to their failure to progress academically (1). In this regard, school of origin may be useful in the “standardization” of GPA, which would serve to better inform the admission process and reduce costs associated with remediation and attrition.

Based on the findings of this study, admission committees at schools of pharmacy should consider the role that the school of origin plays at their respective institutions. The findings of this study indicate that it would improve prediction of pharmacy student success. In accounting for this variable, committees must also consider the politics associated with including such a variable in their admissions formula and realize that some students cannot attend a four-year institution for their pre-pharmacy coursework due to costs.

CONCLUSION

School of origin, operationalized based on the source of the pre-pharmacy math/science GPA, was an intuitive choice that demonstrated the ability to predict academic performance. Issues such as differences in pre-pharmacy GPA and PCAT scores based on a student’s school of origin may be contributing to the ability of these measure to account for variance in pharmacy GPA. These relationships warrant further exploration, but the findings here illustrate a measure that may contribute to the prediction of both academic performance.

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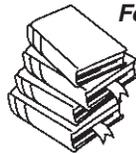
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