White Paper on the Pre-Professional Curriculum in Preparation for Doctor of Pharmacy Educational Programs

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ABSTRACT

Objectives
The objectives of this white paper were to provide an analysis of the abilities that students need to enter pharmacy programs and create model pre-professional curricula to support those needs.

Methods
Pertinent literature, information, and data were retrieved and reviewed following searches of select journals and databases and other resources.

Results
There is currently considerable variation in pre-professional pharmacy curricula and in the undergraduate educational experience. A number of factors have been identified that appear to be associated with academic success during a pharmacy program and on licensing examinations. These data were used to create two pre-professional curricular models that include the development of general and discipline-specific abilities. Challenges remain in accurately evaluating the abilities and attributes of applicants.

Conclusions
Colleges and schools of pharmacy should consider adopting a more consistent pre-professional curriculum on a national level. This pre-professional curriculum should be multi-dimensional, based on needs for future practice, and revised over time.
INTRODUCTION

This white paper was created in response to the request to provide “an analysis of the knowledge, skills, attitudes, and values that students need to enter pharmacy programs, the role of liberal education, and the connection between the pre-professional curriculum and the professional curriculum.” The types of abilities needed for success in a Doctor of Pharmacy program are readily available through documents that describe curricular outcomes and professional practice expectations, but the level of competence needed for each ability is not well described. It is also important to recognize the inter-relationship of the pre-professional and professional curricula.

Background

The pre-professional pharmacy curriculum should be designed to prepare students for the professional curriculum, the profession of pharmacy, and active participation in society.¹ The pre-professional curriculum also provides information that can be used during the admissions process in attempts to select applicants most likely to be successful. The challenges are to develop a pre-professional curriculum that adds value to the professional curriculum, meets current and future needs of the Doctor of Pharmacy curriculum and practice, and is comprehensive without being overwhelming.

There are no data that document the impact of the requirements of the pre-professional pharmacy curriculum on differences in abilities as a student or a practitioner. However, a number of studies have documented the impact of select admissions factors on success or difficulty in Doctor of Pharmacy programs or licensure.

The movement of pharmacy programs to the entry-level Doctor of Pharmacy degree included some modest changes in admissions criteria, including an increase in the minimum pre-professional grade point average (GPA) by some programs and an increased use of interviews and writing exercises during admissions to evaluate communications abilities.² Changes in the pre-professional curriculum were not evaluated.

Goals and Rationale

The goals of this white paper are to provide guidelines for Doctor of Pharmacy programs to use in their evaluation and possible revision of their pre-professional requirements and criteria for admissions. These guidelines have been developed based on analyses and focusing on the abilities that students need to enter pharmacy programs and the profession based on current and
potential future roles and responsibilities of pharmacists. Major considerations in the development of these guidelines are the recognition that student development in the pre-professional and professional curricula is strongly linked and extend well beyond formal course work.

It has been difficult to fully describe details on the level of competency needed in each of the abilities or attributes listed below. Therefore, we have considered that competence is attained in a subject area if a student has passed a course. Colleges and schools of pharmacy may need to place specific grade criteria on courses, particularly for areas that are associated with success or difficulty.

Pre-Professional Curriculum Models

The final products of this white paper are the development of two models of pre-professional pharmacy curriculum models: the fundamental and the expanded curriculum model. The fundamental pre-professional pharmacy curriculum model enables the development of abilities and attributes that are needed to prepare students for current and future Doctor of Pharmacy curriculum, training, and practice. The expanded pre-professional curriculum model goes beyond the fundamental model to more comprehensively develop the requisite abilities and attributes. The expanded pre-professional curriculum allows additional flexibility. These two pre-professional curricula are somewhat time sensitive and are expected to be revised over time.

The definition of the term ‘curriculum’ will be broadened for the purposes of this paper to include the development of abilities through course work, other formal educational activities (traditionally called ‘co-curricular’ activities), and other life experiences or informal educational activities (traditionally called ‘extra-curricular activities’). The term ‘abilities’ is defined in three domains: the cognitive domain, psychomotor domain, and affective domain.

METHODS

Data were collected from a number of sources based on the various information needs for sections of this paper. Current pre-professional curricula were collected from the Pharmacy College Application Service (PharmCAS) database. These pre-professional curricula were tabulated. Current and future needs of abilities for practicing pharmacists are based on relatively recent materials and papers from AACP, Institute of Medicine, APhA, ASHP, and other professional pharmacy organizations. Literature searches were performed primarily through American Journal of Pharmaceutical Education, Journal of Pharmacy Teaching, and the ERIC
database to find articles on pre-professional curricula, admissions criteria, predictors for academic success, and undergraduate education topics and trends. Relative recent books and other resources on the trends in undergraduate and liberal arts education were also reviewed.

**CURRENT PRE-PROFESSIONAL CURRICULA**

Standard 17.1 of the Accreditation Council for Pharmacy Education (ACPE) Accreditation Standards and Guidelines indicate that the pre-professional curriculum should include at least two years of university or college course work and include basic sciences courses such as general and organic chemistry, biological sciences with a focus on human processes and diseases, mathematics, informatics, communication technologies, and physical sciences (physics). Additionally, course work in the humanities, social sciences, and communications should be required. These Standards and Guidelines do not provide recommendations on the specific abilities of applicants, but do refer to the ability to develop cognitive skills and an understanding cultural diversity.

The development of the pre-professional pharmacy curriculum has been driven by individual Doctor of Pharmacy programs rather than through national mandates other than accreditation standards. Additionally, studies have not comprehensively evaluated national trends in the pre-professional curriculum as many colleges and schools of pharmacy transitioned from Bachelor of Science in Pharmacy programs to Doctor of Pharmacy programs or enhanced general abilities (such as communications, critical thinking, problem solving) and discipline specific abilities (such as pharmacoeconomics and pharmacogenetics) within the professional curriculum. However, it is unlikely that the pre-professional curriculum has been stagnant.

The pre-professional course requirements from the distinct Doctor of Pharmacy programs listed and participating in PharmCAS have been collected and tabulated (Table 1). The minimum duration of the pre-professional course work was 3 or 4 semesters in 58 (82%), 5 or 6 semesters in 10 (14%) of the programs, and 8 semesters (a baccalaureate degree) in 3 (4%) of the programs evaluated.

An analysis of the required pre-professional course work from the Doctor of Pharmacy programs has revealed four categories of prerequisite courses based on frequency (Table 1). At least 85% of the programs currently require general biology (and/or cellular or molecular biology), general and organic chemistry, calculus, and English composition or writing. The following courses were required in 50 to 80% of the programs: microbiology, anatomy,
physiology, physics, statistics, public speaking and/or interpersonal communications, economics, and unspecified courses general education, liberal arts, humanities, social sciences and/or behavioral sciences. Biochemistry and psychology and/or sociology courses were required in 20 to 30% of programs. Interestingly, 11% or fewer programs require pre-professional course work in genetics, immunology, ethics, and other cultures and/or diversity. However, a number of factors must be considered when evaluating these frequencies. Course names may or may not reveal the total content of the course. For example, general biology courses may include considerable coverage of cellular and molecular biology and genetics. Additionally, some general abilities (such as communications, ethics and cultural competence abilities) may be developed across a set of general education courses in the pre-professional curriculum instead of within specifically named courses. Additionally, some programs may include courses such as immunology in the professional component of the program, rather than the pre-professional component.

UNDERGRADUATE EDUCATION

Trends in Undergraduate Education

Undergraduate education has gone through a number of changes over the last decade in attempts to enhance the undergraduate experience and learning. These changes have been driven by evidence-based educational research, the need to perform assessment, and results from national surveys on student engagement and satisfaction. Recent trends in undergraduate education have focused on restructuring the learning process, enhancing the development of certain abilities or attributes, and continuing to increase the use of technology.

Attempts have been made to enhance learning by altering the structure of the learning process. Major trends have included the development or increased use of active and interactive learning, cooperative learning, collaborative learning, learning communities, immersion, holistic learning, and small group learning strategies and methods. Small group learning and combined active-cooperative learning have enhanced learning, student attitude toward learning, and increased persistence in math and science curricula. Interactive educational methods appear to enhance problem solving abilities. Many universities have developed learning communities, which appear to enhance the development of abilities and retention.

Many specific abilities and attributes have been the focus of innovations in higher education. Examples include the development of leadership abilities, critical thinking skills, societal
responsibility, and social and emotional intelligence. Colleges and universities have used a number of means of developing these abilities in students, including requiring specific courses for all students to take or allowing for students to choose from select menus of courses that target those abilities. Some institutions have developed individual or a series of required general education / liberal arts courses that target the development of a number of abilities. Examples of required undergraduate courses that develop multiple abilities include a freshman seminar or intellectual heritage course (or course series) required in the first year, service learning as a general requirement, and senior seminar or capstone courses required at the end of the undergraduate program.

Extra-curricular or co-curricular activities that focus on serving surrounding communities are now common at universities and colleges. These activities meet the mission and goals of the university or college and can be managed through academic departments, administrative offices and/or student organizations. Students may develop or enhance their abilities in social responsibility, empathy, leadership, team work, specific discipline or service, and other aspects during these activities. Service learning may also be a component of extra- or co-curricular activities.

Universities and colleges continue to enhance the environment and components used to facilitate learning. The use of technologically advanced classrooms enable faculty to use a variety of teaching and learning methods to enhance understanding and hat benefit students with different learning styles. Such classrooms can also be used to create an efficient method to provide learning simultaneously in local and distant sites as well as instantaneous formative assessments. Classroom design has also been focused on enabling instructor-student and student-student interaction and engagement. There has been an increased use of courseware or software that enables the collection, distribution and use of course material and interaction and communication among students and faculty by synchronous and asynchronous means.

**Liberal Education and the Liberal Arts**

A liberal education is meant to prepare students for the complexity, diversity, and change encountered in society and life through a broad education in addition to specialized education in a field of interest. A liberal education should develop social responsibility and skills in communication and problem-solving. The liberal arts enhance general knowledge and intellectual abilities through studies in language, literature, history, philosophy, fine arts, and
science. Others have defined the liberal arts as a well-rounded education in the humanities, arts, and sciences. These general abilities from the liberal arts are considered separate from professional or vocational abilities, but also enhance professional and vocational abilities. The role of a liberal education in the pre-professional and professional curriculum is to enable the student to achieve academic, professional, and societal success in the professional educational program, practice as a pharmacist, and engagement as an informed citizen.

GENERAL ABILITIES NEEDED OR DESIRED

A number of general abilities are considered to be fundamental for students entering Doctor of Pharmacy programs, including communications, interaction, critical thinking, problem solving, decision-making, empathy, and self-learning abilities. Measurements of the level of ability or performance in many of these general abilities have been associated with academic and/or post-graduate success, as noted below. General abilities are defined as those abilities that are needed or desirable in the development of any professional. This section provides an overview of data, perceptions, and the potential impact of undergraduate education on the development of the specific general abilities that have been identified as needed or desired upon entry into a Doctor of Pharmacy program.

Communication Abilities

Communication abilities are considered to be essential for success in a Doctor of Pharmacy program and as a pharmacist. Communication abilities of applicants have been evaluated through Pharmacy College Admissions Test (PCAT) subtest scores, essays, small group exercises, and interviews. Student performance in pharmacy programs has correlated with communications abilities (essay, PCAT verbal and reading subtest scores), but did not fit into a multiple regression mode multiple regression models of first year pharmacy GPA, academic standing, and whether or not students failed a pharmacy course in a historically black school of pharmacy. Many colleges and schools of pharmacy evaluate communications abilities as part of the admissions process. PCAT verbal subtest scores were correlated with overall pharmacy GPA in all pharmacy students in one program and African American and Asian pharmacy students in another program, but not with first year pharmacy GPA in another study. PCAT reading subtest scores correlated with first year pharmacy GPAs in some, but not all studies. Scores from structured interviews, scores on writing samples, and scores on a verbal standardized multiple choice test have also correlated with academic
performance. PCAT verbal subtest scores correlated with performance on the North American Pharmacist Licensure Examination (NAPLEX). Students who have English as a second language or not their best language may not fully understand common and basic terms used in pharmacotherapeutics course examinations. However, English as a second language was not a factor in predicting overall pharmacy GPA or success in another pharmacy program.

Written communication skills were ranked among the top five most important pre-professional attributes for pharmacy students. Writing skills are critical for the development of information used in educational activities, patient education, formulary decisions, documentation of pharmacy services, and other activities. Scores on admissions essays have correlated with performance in traditional and distance education-based Doctor of Pharmacy programs. There also may be a strong association between writing skills and critical thinking skills.

Reading skills are important in Doctor of Pharmacy programs and practice as a pharmacist. The PCAT reading subtest score correlated with cumulative pharmacy program GPA. An analysis of third year Doctor of Pharmacy students at one school of pharmacy revealed that their average vocabulary, comprehension, and composite grade levels were 16.4 to 16.5, but individual students ranged from 9.3 to 18.9 using the Nelson-Denny Reading Test. However, readability grade levels for required pharmacotherapy textbooks averaged 18.1 (range 16.3 to 19.5), for medical guidelines averaged 19.2 (range 17.5 to 21.0), and for select medical journals reportedly averaged 16.85 to 17.8 as calculated using the Gunning FOG readability formula. These findings were consistent with findings that the reading grade level of medical interns was also lower than the readability grade level of medical journals. Nelson-Denny Reading Test determined grade equivalents for vocabulary, comprehension, and composite all correlated with PCAT reading subtest scores.

Oral communication skills were ranked among the top five most important pre-professional attributes for pharmacy students. Other than data from studies on interviews and nonnative English speakers provided above, little research has been done to determine the impact of oral communications skills at admission on performance during or after the pharmacy professional curriculum.

Interaction Abilities

Interaction skills are becoming more important in education and practice environments. Problem-based learning, small group projects, problem-solving courses, and experiential courses
focus on group interactions. The future of patient care is based on team-based care.\textsuperscript{27} As noted above, a number of universities and colleges have implemented general methods to enhance interaction skills through cooperative learning, collaborative learning, learning communities, small group learning, and service learning. Interaction abilities of applicants have been evaluated through small group exercises and interviews.

Leadership skills are also deemed to be important attributes for incoming pharmacy students.\textsuperscript{24} However, it is unclear if leadership abilities are associated with success during or following a Doctor of Pharmacy program. There is no universally accepted definition of leadership. Additionally, not everyone can be the leader as there is only room for one leader. Perhaps leadership should be defined on a continuum, including leadership attributes that are needed in followers as well as leaders. The lack of universality of a definition of leadership has made it difficult to study, particularly in applicants to the professional pharmacy program.

Scores on a personal relations, sociability, emotional stability, and ascendancy (activity, self-assurance and independency in groups) scales from the Gordon Personal Profile-Inventory were not different between pharmacists who were active (serve as preceptors, active in professional organizations, pursue additional education) compared to those who were nonactive.\textsuperscript{28} Students scored lower on the personal relations, emotional stability and ascendancy scales and higher on the sociability scale than pharmacists, but is unclear how these attributes are developed and whether or not pre-professional scores on these scales would be associated with performance in a Doctor of Pharmacy program or as a pharmacist.

On-line social networking continues to expand, with estimates that 80 to 90\% of university and college students have accounts on a social networking site according to an excellent review of on-line social networking sites and implications for pharmacy and higher education.\textsuperscript{29} Social networking sites enhance social interactions and may assist students develop their own identity, find their place in the university or college social network, and continue their enrollment. However, postings by students on these sites may also document or perform inappropriate or illegal behaviors. Heavy use of a social networking site has been associated with lower GPAs in a general college students living on-campus.\textsuperscript{29} However, it is unclear whether or not social networking is associated with performance during or following pharmacy or other professional degree programs.

\textbf{Cognitive Abilities}
Critical thinking skills are thought to be important for the delivery of pharmacy-based care and also for progression through Doctor of Pharmacy programs.\textsuperscript{12,24} Incoming abilities in critical thinking may be crucial since it is difficult to document improvements in critical thinking abilities even following courses or curricula that attempt to develop critical thinking abilities. However, there appear to be inconsistency results on the impact of pre-professional scores in critical thinking on performance during and after Doctor of Pharmacy programs. Pre-professional scores on a standardized critical thinking scale (Watson-Glaser Critical Thinking Appraisal) did not correlate with performance in a Doctor of Pharmacy program.\textsuperscript{30} However, scores on a different critical thinking scales (California Critical Thinking Skills Test, California Critical Thinking Disposition Inventory) correlated with overall Doctor of Pharmacy program GPA, first to third year GPA, advanced pharmacy practice experience GPA, and/or scores on the NAPLEX.\textsuperscript{13,22}

Motivation to use critical thinking skills may be even more important.\textsuperscript{12} Pharmacists who served as preceptors, were active in pharmacy organizations, and who completed additional education had higher scores in original thinking (intellectual curiosity and enjoy difficult problems, thought provoking questions, and thinking about new ideas, from the Gordon Personal Profile-Inventory) than nonactive pharmacists.\textsuperscript{28} Pharmacy student scores on the ratings were lower on the original thinking scale than pharmacists, but it is unclear how this trait is developed and whether or not a higher pre-professional score on this scale is associated with performance in a Doctor of Pharmacy program or as a pharmacist.

**Ethics and Moral Reasoning**

Ethics and moral reasoning abilities are needed on admission into the professional curriculum because of the likelihood that students will be exposed to ethical dilemmas during on-campus courses, introductory pharmacy practice experiences, professional organization activities, and pharmacy work experiences. These abilities will also be further developed during the professional curriculum. Ethics was ranked among the top five most important pre-professional attributes for pharmacy students.\textsuperscript{24} High moral reasoning, measured using the Defining Issues Test, was associated with higher abilities in clinical reasoning in practitioners,\textsuperscript{31} but was not associated with performance in a Doctor of Pharmacy program.\textsuperscript{30} Interestingly, pharmacy students and practitioners scored lower on moral reasoning tests than medical and dental
Moral reasoning can be part of the admissions criteria despite some difficulties in evaluating this attribute.

Relatively recent movements in higher education have been to include coursework in ethics and moral reasoning as a general education requirement, to incorporate a strategy of ethics and moral reasoning across the undergraduate curriculum and/or student life, and to include development of ethics and moral reasoning within most degree programs (business, education, biology, computer science, etc.) as stand alone courses or components of discipline-specific courses. There are a wide variety of approaches, but it is unclear which one is the best approach and how much impact can be demonstrated in ethics or moral reasoning in the pre-professional and professional curricula.

**Cultural Competence and Diversity Awareness**

Cultural competence and diversity awareness are important in undergraduate and pharmacy education. Liberal education and general education at the vast majority of universities and colleges include requirements and elective opportunities for the development of understanding other cultures and diversity. It is unclear how a student’s pre-professional development of cultural competence and diversity awareness will influence their success as a student and professional. However, it is likely that such competence and awareness is associated with other desirable attributes such as caring and communication skills.

**Societal Responsibility**

Most universities and colleges appear to address the importance and development of social responsibility and informed citizenship through required or elective courses or through extra-curricular activities. These are important attributes for pharmacy students and pharmacists to meet the needs of society as professionals and citizens. Guideline 17.3 of the ACPE Standards and Guidelines states that “Admission criteria, policies, and procedures should take into account necessary scholastic accomplishments, as well as other desirable qualities (such as intellectual curiosity, leadership, emotional maturity, empathy, ethical behavior, motivation, industriousness, and communication capabilities) that support the student’s potential to become a self-directed lifelong learner and an effective professional….In-person standardized interviews of applicants, including evaluation of verbal communication skills, understanding of the pharmacy profession, and commitment to patient care, must be part of the admission process.”
Many schools incorporate an assessment of affective or professionalism qualities in the admission process through the use of personal interviews or essays. Applicants can sometimes “fake” responses knowing what characteristics are desirable. Concerns about using these characteristics in making admission decisions also include the possibility of being discriminatory, the validity and reliability of instruments to measure these attributes, and the potential resultant decreased emphasis on academic preparation. A standardized assessment of affective qualities has been developed to identify applicants with characteristics such as community service orientation, empathy, helping orientation and responsibility. Scores on this instrument were a significant predictor of academic success in their curriculum. Ratings from a similar instrument using forced-choice self-descriptions of empathy were more predictive of program performance in simulated patient-pharmacist interactions than a more traditional self-rating approach.

A survey of 52 colleges and schools of pharmacy examined how student professionalism was assessed and enhanced. In the recruitment and admissions phases, 75% of respondent programs indicated that prospective students were screened to determine their potential for professional development. However, only 26% of the programs used a standard instrument. Ninety percent of the respondents did consider an applicant’s potential for professional development in the admissions process.

Community service and service learning projects are increasingly being required or recommended in high school and college curricula. Little or no data are available on the value, validity, or reliability of these activities in the admission process or development of professionalism.

Perhaps, the most practical approach to determine motivation to become a pharmacist and understanding of the profession would be to assess the time and money spent, and the depth and breadth of knowledge possessed. Review of a resume and an interview can determine what an applicant has invested in learning about or working in a pharmacy. The impact of prior work experience in a pharmacy on overall success in an pharmacy academic program is unclear. However, no or little work experience in pharmacy prior to entering the professional program has been associated with decreased performance in a course on the top 200 drugs. Although shadowing or interacting with pharmacists or other health care professionals or volunteering in a health care setting seem desirable when evaluating an applicant, it is unclear if these activities
are associated with success in the professional program. Additionally, there is little or no data or even a commonly accepted definition of “understanding the pharmacy profession” or “commitment to patient care”.

**Other Personal Abilities and Attributes**

Personal attributes that appear to be desirable for entering pharmacy students include maturity, motivation, compassion, empathy, integrity, altruism, respect, responsibility, service orientation, good work habits, emotional intelligence, and interpersonal relationship skills.\(^{24,35}\) Character and motivation were each ranked among the top five most important pre-professional attributes for pharmacy students.\(^{24}\) Attributes that have been associated with performance in professional pharmacy courses include self-efficacy (the student’s ability to estimate their own performance) and possibly motivation.\(^{36,37}\) However, scores on the Gordon Personal Profile-Inventory scales for responsibility, cautiousness, and vigor were not different between pharmacists who were active (serve as preceptors, active in professional organizations, pursue additional education) compared to those who were nonactive.\(^{28}\) Students scored lower on these scales than pharmacists, but it is unclear how these attributes are developed and whether or not pre-professional scores on these scales would be associated with performance in a Doctor of Pharmacy program or as a pharmacist. Emotional intelligence may be a better predictor of career success than intelligence quotient.\(^{38,39}\) Empathy is a desirable trait for pharmacists and should also be considered during admissions.\(^{24}\) The assessment of empathy through forced-choice self-descriptions of empathy was a stronger predictor of empathy scores in simulated patient-pharmacist interactions compared to direct self-ratings of empathy.\(^{32}\) Many of these attributes and characteristics may provide insights into a student’s future development in professionalism. Professionalism is generally evaluated after entry into the professional curriculum, but methods used to measure professionalism\(^{40,41}\) may provide useful insights during the evaluation of applicants.

Research skills are desirable for students entering a Doctor of Pharmacy program, but only 25% of programs responding to a survey required completion of a research project as part of the program.\(^{42}\) Research skills are developed in Doctor of Pharmacy programs at various levels, but incoming students should have an understanding of the scientific method and statistics (see below).
It is unclear if age is a factor in program performance. Some studies have found that age was inversely correlated with first semester or first year GPA in a Doctor of Pharmacy program, but other studies found no correlation. Students who graduated and passed the NAPLEX were younger than the combined group of those who did not graduate or graduated but failed the NAPLEX. This study also found a trend (p>0.05) for an inverse association between age and NAPLEX scores.

**CONTENT-SPECIFIC ABILITIES NEEDED**

Prior work on determining an appropriate pre-professional curriculum for pharmacy students included a survey of deans and other academic administrators of colleges and schools of pharmacy using a 5-point Likert scale (from 1 = strongly disagree to 5 = strongly agree). There was reasonably strong agreement that the pre-professional curriculum should include (average rating from 5.0 to 4.0, listed from high to low) general and organic chemistry, general biology, English composition, calculus, anatomy and physiology, public speaking, and microbiology courses. There was moderate agreement (average ratings of 3.9 to 3.3) that the pre-professional curriculum should include statistics, biochemistry, ethics, physics, cellular biology, English literature, molecular biology, genetics, sociology, immunology, and business courses. Ratings were neutral (average ratings of 3.2 to 2.8) for foreign language, political science, fine arts, and zoology courses. Ratings were not supportive (average ratings less than 2.8) for requiring bacteriology, physical education, geography, physical chemistry, music appreciation, anthropology, and religion courses in the pre-professional curriculum. There was moderate agreement that preadmissions evaluations should include the PCAT (mean rating of 3.4) and other professional testing (mean rating of 3.5). Professional testing performed during admissions included a writing sample, problem solving exercises, or other sample exercises. These data are useful in the development of a pre-professional curriculum and in the development of a set of abilities needed prior to entry into the Doctor of Pharmacy curriculum.

A number of studies have attempted to determine factors that predict performance, success, or difficulty in the Doctor of Pharmacy program. The pre-professional combined math and science GPA has been found to correlate with academic performance, as measured by GPA, in the first semester or first year for students in the standard and distance pathway of Doctor of Pharmacy programs, and with performance in a pharmacy administration course. Pre-professional science GPA fit into multiple regression models of academic standing and whether
or not students failed a pharmacy course in a historically black school of pharmacy.\textsuperscript{15} However, pre-professional grades in biology, chemistry, and mathematics courses did not correlate with scores on the NAPLEX.\textsuperscript{22}

Should the pre-pharmacy curriculum include earning a baccalaureate degree? The answer is unclear. There was no consistent agreement on the length of the pre-professional curriculum or whether a baccalaureate degree should be required in the survey of pharmacy program administrators.\textsuperscript{16} Performance or success in the first semester or first year of a Doctor of Pharmacy program, as measured by GPA, was associated with having earned a baccalaureate degree or an associate degree prior to entering the pharmacy program.\textsuperscript{21,43,45} Additionally, having a previous degree fit into multiple regression models of first year pharmacy GPA and academic standing, but not a model of whether or not students failed a pharmacy course in a historically black school of pharmacy.\textsuperscript{15} However, having a baccalaureate or masters degree did not correlate with scores on annual progress testing or the NAPLEX.\textsuperscript{22,46}

**Chemical Sciences**

Knowledge in general and organic chemistry are fundamental in the development of knowledge of the chemistry, pharmaceutics, compounding, and action of drugs. Although academic pharmacy administrators perceive a need for biochemistry as part of the pre-professional curriculum, few programs have such a requirement (Table 1).\textsuperscript{16} Many Doctor of Pharmacy professional curricula include biochemistry courses or content in the professional curriculum.

The PCAT chemistry subtest score and pre-professional chemistry GPA correlated with overall pharmacy GPA, performance in a pharmacy administration course and performance on the NAPLEX,\textsuperscript{19,22,36} but not with first year pharmacy GPA.\textsuperscript{21} However, the PCAT chemistry subtest score fit into a multiple regression models of first year pharmacy GPA, academic standing, and whether or not students failed a pharmacy course in a historically black school of pharmacy.\textsuperscript{15} Grades in organic chemistry have been associated with first year success and failure in a pharmacy program.\textsuperscript{45} Advanced course work in chemistry and taking organic chemistry at a 4-year institution were associated with higher PCAT chemistry subtest scores.\textsuperscript{22} Performance on NAPLEX was associated with the PCAT chemistry subtest score but was not associated with taking advanced chemistry courses prior to entering the professional program.\textsuperscript{22} Additional analyses found no difference in taking pre-professional advanced chemistry courses
when comparing those who graduated and passed the NAPLEX with the combined group of those who did not graduate or graduated but failed the NAPLEX.22

**Biological Sciences**

The general biological sciences, including at least some knowledge in cellular and molecular biology, are needed in Doctor of Pharmacy curricula for the development of understanding of biopharmaceutics, pharmacology, pathophysiology, and therapeutics. Microbiology, anatomy and physiology are commonly, but not consistently pre-professional requirements (Table 1), but are also needed in understanding of pharmacology, pathophysiology, and therapeutics. Additionally, a small fraction of pharmacy programs require genetics and/or immunology in the pre-professional curriculum (Table 1). The inclusion or exclusion of these other biological sciences in the pre-professional curriculum is likely to determine what is covered in the professional curriculum. Unfortunately, there are no data to indicate whether or not pre-professional requirements or performance in these other biological science courses is associated with success as a pharmacy student or pharmacist.

Pre-professional biology course GPA met the criteria to become a variable in the discriminate analysis multivariate model for predicting first year GPA and correlated with the cumulative pharmacy GPA, but did not correlate with first year pharmacy program GPA.14,19 Advanced course work in biology was associated with higher PCAT biology subtest scores.22 PCAT biology subtest scores were associated with overall pharmacy GPA,19 but not with first year pharmacy GPA in another study.21 Performance on the NAPLEX was associated with PCAT biology subtest scores but was not associated with taking advanced biology courses prior to entering the professional program.22 Additional analyses found no difference in taking pre-professional advanced biology courses when comparing those who graduated and passed the NAPLEX with the combined group of those who did not graduate or graduated but failed the NAPLEX.22

**Mathematics and Statistics**

Mathematics skills are likely to be important during and after the Doctor of Pharmacy curriculum in performing drug dosing, pharmacokinetic, and other calculations.12 Calculus is preferred to more fully understand pharmaceutics, pharmacodynamics, and pharmacokinetics content in the professional curriculum. Basic mathematics skills, measured using a standardized test, were found to correlate with math-science GPA, PCAT composite score and quantitative
subtest score, and performance in a first year pharmacy calculations course.\textsuperscript{47} First year and overall pharmacy GPA each correlated with pre-professional mathematics course GPA and PCAT quantitative or mathematics subtest scores, but not in all studies.\textsuperscript{14,19,21} Advanced course work in mathematics was associated with higher PCAT quantitative subtest scores.\textsuperscript{22} Performance on the NAPLEX was associated with PCAT quantitative subtest scores, but was not associated with taking advanced mathematics courses prior to entering the professional program.\textsuperscript{22} Additional analyses found no difference in taking pre-professional advanced mathematics courses when comparing those who graduated and passed the NAPLEX with the combined group of those who did not graduate or graduated and failed the NAPLEX.\textsuperscript{22}

Statistics are required components of the pre-professional curriculum in 56 to 69\% of the Doctor of Pharmacy programs (Table 1).\textsuperscript{42} The knowledge of statistics is important to more fully understand research and its application to therapeutics and practice.

**Information Technology**

Information technology skills are increasing important in the education and practice of pharmacy.\textsuperscript{12} The development of information technology skills has been shifted, at least in part, to primary and secondary education. These skills do not routinely appear as separate courses in general education requirements. However, information technology skills are developed during orientation to the library and throughout many undergraduate curricula.

**Humanities and Social Sciences**

The humanities include literature, languages, philosophy, arts, and history. These are part of the liberal arts. Communication, ethics, moral reasoning, and critical thinking abilities are components of humanities and important abilities for pharmacy students and practitioners,\textsuperscript{1} as described above. Abilities in other humanities are essential to enable the full development of a fully engaged professional and citizen. Fulfillment of general education requirements at the vast majority of colleges and universities should satisfy these needs.

The social sciences include psychology, sociology, economics, law, political science, and anthropology. Abilities within several of these areas are essential components of the pre-professional curriculum, whereas others are important but perhaps not essential. Although currently required specifically by only 27\% of the programs surveyed (Table 1), sociology and psychology should be considered essential in the pre-professional curriculum. Knowledge of psychology is essential in better understanding working with and influencing others, the potential
psychiatric impact of illness, and psychiatric diseases themselves. A foundation in sociology
also is essential in having students ready to better understand health care systems and
organizations as well as the roles and responsibilities of health care professionals and
organizations in society. A solid foundation in economics is also needed so that students are able
to expand and apply their understanding of the basic economic concepts to pharmacoeconomics
and medical economics. A total of 59% of current pre-professional curricula require course
work in macroeconomics and/or microeconomics (Table 1). An understanding of the basic
elements of law is very beneficial, particularly given the regulations that govern pharmacy
practice and the litigious nature of the health care environment. Abilities in political science are
also beneficial, but not essential, in enabling students to better understand the political arena so
that they can understand the needs and potentially participate in attempts to enhance health care
and pharmacy practice through laws and regulations.

The studies that evaluate the impact of pre-professional abilities in select humanities and
social sciences on the performance of pharmacy students or pharmacists are listed in other
sections of this paper. However, these studies have not evaluated the relationships of many of
these abilities, particularly those in psychology, sociology, and economics.

ACADEMIC ABILITY

Learning and Study Strategies

Learning and study strategies are likely to be associated with academic success in the pre-
professional and the professional curriculum. However, performance in the first semester and
first year of a Doctor of Pharmacy program, measured by GPA, did not correlate with scores on a
standardized instrument (the Learning and Study Strategies Inventory) to measure these
strategies.30 It is unclear if it is the nature of the instrument, the lack of any impact, or the
admissions process that selects students with similar learning and study strategies or abilities.

Academic Performance

Academic performance is a consideration for entry into Doctor of Pharmacy programs since
many, but not all,13,21 studies have documented a correlation between the pre-professional and
the professional program GPA.12,14,19,43,45 Pre-professional overall GPA fit into a multiple
regression model of first year pharmacy GPA, but not regression models of academic standing
and whether or not students failed a pharmacy course in a historically black school of
pharmacy.15 The pre-professional GPA was not correlated with performance on annual progress
Interestingly, the pre-professional required course GPA was not associated with pharmacy program GPA, but was even less correlated than cumulative pre-professional GPA. Minimum accepted pre-professional GPA ranges from 2.0 to 3.0 (overall mean of 2.5 to 2.6), but the actual entering average GPA ranges from 2.9 to 3.7 (mean of 3.3). Pre-professional GPAs were correlated with scores on the NAPLEX in one study but not in another.

**MAKING CONNECTIONS**

Connections between the pre-professional and professional programs can differ based on physical location of institutions offering the programs and the presence of a formalized relationship between the two entities. The pre-professional program has a major effect on the content of the professional program with regard to course requirements. Communication between the student with pharmacy faculty and administrators will be affected by location of programs and formalized relationships. Teaching and learning methodologies and techniques may differ or be in congruence between the pre-professional and professional pharmacy programs. The culture of the learning environment and the opportunity to participate in various activities and/or experiences may differ as well.

**Pre-pharmacy programs at institutions with Doctor of Pharmacy Programs**

For those institutions offering a Doctor of Pharmacy program, communication, facilitation, and collaboration between faculty of pre-professional and professional coursework is easier. Communication is enhanced due to ease of interactions and general knowledge of institutional offerings. The potential for collaborating and relating pre-professional and professional coursework and requirements is enhanced. In some cases, potential applicants may even be able to enroll in a pre-professional course offered by the pharmacy faculty. With optimal course selection, a potential applicant might have opportunities to complete a double degree or a minor in the time period of the pharmacy program.

A single institution may have institution wide philosophies or policies regarding teaching and learning methodologies, thus allowing for a smoother transition to professional coursework. Potential applicants find it easier to obtain information about the pharmacy program and have a better knowledge of the program due to accessibility to faculty and pharmacy students. The admission process may be less anxiety provoking, easier, and more efficient because the Doctor of Pharmacy program is part of the institution.
Potential applicants in the pre-pharmacy program may have the opportunity to participate in student pharmacy organizations and events. Interaction with pharmacy students on campus would provide more opportunities to learn about the profession and what is involved with learning how to be a health professional.

Pre-pharmacy programs at institutions affiliated with institutions offering Doctor of Pharmacy Programs

Some institutions offering Doctor of Pharmacy programs have developed formal affiliation agreements with other institutions who offer pre-pharmacy programs. In one instance, a combined 3-4 program results in students earning both the bachelor of science degree usually in biology, chemistry or biochemistry at one institution and the Doctor of Pharmacy degree at the other institution. The benefits of this approach are enhanced recruitment and knowledge of the pharmacy program. Many such arrangements guarantee a number of seats in the pharmacy program for qualified applicants from the pre-pharmacy program, thereby easing some anxiety associated with the admission process.

Usually, coursework pre-approved or chosen by the pharmacy program makes choice of coursework in the pre-professional program easier and simpler for the potential applicant. The transition to the pharmacy program may be easier as problems have already been identified and solved.

Pre-pharmacy programs at institutions that do not have and are not affiliated with Doctor of Pharmacy Programs

Potential applicants must work harder to find information about pharmacy programs and to identify appropriate pre-pharmacy coursework. They must prospectively identify programs of interest and communicate with these programs well ahead of application deadlines. Opportunities to interact with pharmacy faculty and students would not be available and learning about the culture of the profession may be difficult or not available. Alternatively, the opportunity to be involved in more diverse experiences may be found at an institution without any affiliation with pharmacy. Having students with varied background and experiences would bring diversity and richness to the pharmacy student class.

SUMMARY

There is considerable variation in the pre-professional pharmacy curricula, which may parallel some variation in the professional curricula. We would prefer more standardized pre-
professional curricula to provide more consistent direction for applicants and for colleges and schools of pharmacy. The pre-professional curriculum should develop the general and the specific abilities needed to be successful as a pharmacy student and practitioner. Changes in undergraduate education contain many elements that appear to better prepare students for entry into the professional curriculum. The major factors identified to be associated with success in the professional pharmacy curriculum and/or licensing examination include undergraduate performance, motivation, community service orientation, and abilities in communications, critical thinking, empathy, chemical sciences, biological sciences, and mathematics. Other abilities or attributes that appear to be important but have not been associated with success in a Doctor of Pharmacy program include interaction, leadership, cultural competence, diversity awareness, understanding of the pharmacy profession, emotional intelligence, technology, humanities, social sciences, and learning and study strategies. Additionally, the pre-professional curriculum and professional curriculum need to be coordinated with each other and revised when needed to keep pace with current and future needs.

Although 82% of programs require 4 semesters of pre-professional course work, it may take 5 or 6 semesters for many students to meet these requirements based on the number and sequencing of courses needed. Competitiveness for entry into Doctor of Pharmacy programs has resulted in many students being admitted having completed numbers of prior courses that markedly exceed the minimum pre-professional requirements. Alternatively, a number of colleges and schools of pharmacy enter a large number of their students through 4-semester pre-professional curricula within their own or affiliated institutions.

The basic elements of the current pre-professional course requirements (general biology, general and organic chemistry, calculus, composition) for the vast majority of pharmacy programs seem very similar to requirements over the last one to two decades. Other courses required in more than 50% of programs (microbiology, anatomy, physiology, physics, statistics, public speaking and/or interpersonal communications, economics, and unspecified courses in general education, liberal arts, humanities, social sciences and/or behavioral sciences) appear to be fundamental, as well. Although not commonly components of pre-professional curricula, courses in biochemistry, psychology, sociology, genetics, immunology, ethics, and other cultures and/or diversity would also seem appropriate in pre-professional curricula. Developing an appropriate balance of general and specific abilities is essential.
The following recommendations are based on the data provided above, but also on other factors. The vast majority of the measures of success provided in the literature and described are limited to GPAs and passing licensing examinations. Other measures of success need to be considered, including success in patient care, pharmacy practice settings, professional organizations, and public health and community service settings during the professional curriculum and following graduation.

**RECOMMENDATIONS**

**General Recommendations**

We recommend that the colleges and schools of pharmacy use completion of pre-professional course work (outlined below) and indicators of academic performance, general abilities (communications, critical thinking, moral reasoning, interaction, cultural competence, etc.), and other attributes when evaluating applicants for admissions to the pharmacy professional program. The strong association with pre-professional GPA with performance in the professional program supports its continued use in admissions decision, but additional criteria should also be used. Although not well studied, colleges and schools of pharmacy should also consider grading criteria for specific required pre-professional course work, such as requiring a minimum grade of B. The PCAT appears to be a reasonable method of assessing content-specific and general abilities in addition to being useful in admissions decisions. However, programs should determine whether or not PCAT subtest scores add value beyond grades in specific courses to predict success or difficulty in the professional curriculum. An analysis of feeder schools’ courses, curricula, and students may also provide insights for use during admissions deliberations.

An evaluation of an applicant’s general abilities should minimally include an interview that provides at least an evaluation of on demand oral and written communication abilities. Interviews should be structured to determine at least a few of the following: thinking abilities, motivation, interaction abilities, knowledge of the pharmacy profession and/or health care, thinking abilities, and desirable attributes (caring, empathy, leadership, social responsibility, etc.). Structured interviews by trained interviewers may be useful, but standardized instruments should also be considered and evaluated for use in the admissions process. An evaluation of each of these methods is beyond the scope of this white paper, but some examples are provided
above. Efforts should be made to study the use of methods to evaluate these attributes and the impact of those attributes on success as a pharmacy student and graduate.

**Fundamental Pre-Professional Curriculum and Activities**

The fundamental pre-professional curriculum and activities should include a liberal education, a foundation in the sciences and mathematics, and general appreciation of pharmacy as a health sciences profession. Many colleges and schools of pharmacy should review and, if necessary, enhance their requirements to provide a full spectrum of liberal education components. We recommend courses in English composition, public speaking or interpersonal communications, psychology, sociology, economics, and general education requirements that include U.S. culture and global/international studies (Table 2). Students should also have been exposed to ethics, moral reasoning, cultural competence, diversity awareness, group interaction, and critical thinking through their course work. Finally, students should have worked or volunteered in a pharmacy setting (or at least a health care setting) to have developed a perspective on pharmacy. The pre-professional science and mathematics curriculum should include general biology that also focused on cellular biology, general and organic chemistry, calculus, physics, statistics, microbiology, anatomy, and physiology (Table 2). These courses should also focus on the development of inquiry and the scientific method. The duration of this pre-professional curriculum is more likely to equate to at least 5 semesters of course work for most students.

**Extended Pre-Professional Curricula and Activities**

Colleges and schools of pharmacy should consider extending the pre-professional curriculum to include the development of a more standardized and complete set of courses and experiences. Most likely, the pre-professional curriculum should be at least 6 semesters long, and is likely to lead to the attainment of a baccalaureate degree given the broad spectrum of courses we propose for the expanded pre-professional curriculum. We feel this is necessary to develop the full range of abilities and attributes needed for success as a student and practitioner. The completion of the baccalaureate degree is likely to enhance the student’s general abilities, but will also enhance their maturity and demonstrate their ability to complete a program. The additional science courses to be added to the fundamental pre-professional curriculum include biochemistry, genetics, and possibly immunology (Table 2). Such a curriculum would also enable the more complete development of general abilities and a liberal education.
Such system-wide changes should not be taken lightly and will require considerable
discussion and resolution. These changes would require marked changes in a number of Doctor
of Pharmacy that have pre-pharmacy programs at their own or affiliated institutions.

CONCLUSIONS

Enhancements and standardization in the pre-professional pharmacy curriculum has the
potential to continue to advance the abilities of pharmacy students and eventually of pharmacists.
Efforts should be made to expand the pre-professional curriculum to more completely develop
general and specific abilities that reflect educational and practice needs.
ACKNOWLEDGEMENTS

We wish to thank Robert “Buzz” Kerr and Jim Uchizono for their help in developing the general concepts and initial outline for this white paper. We also wish to thank Cecilia Plaza, Gary Oderda, and the reviewers for their assistance, insights and direction.
Table 1. Percent of 71 Doctor of Pharmacy programs at colleges and schools of pharmacy requiring the following courses. Data are from PharmCAS.

<table>
<thead>
<tr>
<th>Courses Required</th>
<th>Required</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>General, Cellular and/or Molecular Biology</td>
<td>67 (94%)</td>
<td>4 others require Anatomy &amp; Physiology</td>
</tr>
<tr>
<td>Microbiology</td>
<td>46 (65%)</td>
<td></td>
</tr>
<tr>
<td>Anatomy</td>
<td>44 (62%)</td>
<td></td>
</tr>
<tr>
<td>Physiology</td>
<td>38 (54%)</td>
<td></td>
</tr>
<tr>
<td>Genetics</td>
<td>4 (6%)</td>
<td></td>
</tr>
<tr>
<td>Immunology</td>
<td>3 (4%)</td>
<td></td>
</tr>
<tr>
<td>General Chemistry</td>
<td>71 (100%)</td>
<td></td>
</tr>
<tr>
<td>Organic Chemistry</td>
<td>71 (100%)</td>
<td></td>
</tr>
<tr>
<td>Biochemistry</td>
<td>14 (20%)</td>
<td></td>
</tr>
<tr>
<td>Calculus</td>
<td>68 (96%)</td>
<td></td>
</tr>
<tr>
<td>Physics</td>
<td>54 (76%)</td>
<td></td>
</tr>
<tr>
<td>Statistics</td>
<td>40 (56%)</td>
<td></td>
</tr>
<tr>
<td>Public Speaking and/or Interpersonal Communications</td>
<td>44 (62%)</td>
<td></td>
</tr>
<tr>
<td>English Composition and/or Writing</td>
<td>61 (86%)</td>
<td></td>
</tr>
<tr>
<td>Economics</td>
<td>42 (59%)</td>
<td></td>
</tr>
<tr>
<td>Psychology and/or Sociology</td>
<td>19 (27%)</td>
<td></td>
</tr>
<tr>
<td>Ethics</td>
<td>4 (6%)</td>
<td></td>
</tr>
<tr>
<td>Other Cultures and/or Diversity</td>
<td>8 (11%)</td>
<td></td>
</tr>
<tr>
<td>Fine Arts</td>
<td>8 (11%)</td>
<td></td>
</tr>
<tr>
<td>Other but unspecified General Education, Liberal Arts, Humanities, Social Sciences and/or Behavioral Sciences</td>
<td>55 (77%)</td>
<td></td>
</tr>
</tbody>
</table>
Table 2. Recommended courses in the fundamental and extended pre-professional curricula.

<table>
<thead>
<tr>
<th>Course(s)</th>
<th>Comment</th>
<th>Semester Courses</th>
</tr>
</thead>
<tbody>
<tr>
<td>General Biology</td>
<td>With laboratory</td>
<td>2</td>
</tr>
<tr>
<td>Microbiology</td>
<td>With laboratory</td>
<td>1</td>
</tr>
<tr>
<td>Human Anatomy and Physiology</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>General / Inorganic Chemistry</td>
<td>With laboratory</td>
<td>2</td>
</tr>
<tr>
<td>Organic Chemistry</td>
<td>With laboratory</td>
<td>2</td>
</tr>
<tr>
<td>Calculus</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Physics</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Statistics</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Economics (General economics, microeconomics, or macroeconomics)</td>
<td>Prefer both microeconomics and macroeconomics</td>
<td>1</td>
</tr>
<tr>
<td>Composition</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Communication – interpersonal or public speaking</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Psychology</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Sociology</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Other General Education Requirements (U.S. culture, global / international studies, cultural competence / diversity awareness, ethics and moral reasoning, group interaction, others)</td>
<td></td>
<td>Varies</td>
</tr>
</tbody>
</table>

Additional Courses Recommended for the Extended Pre-Professional Curriculum

<table>
<thead>
<tr>
<th>Course(s)</th>
<th>Comment</th>
<th>Semester Courses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Genetics</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Biochemistry</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Immunology</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Completion of both Macroeconomics and Microeconomics</td>
<td></td>
<td>1 additional</td>
</tr>
<tr>
<td>Completion of All General Education Requirements</td>
<td></td>
<td>Varies</td>
</tr>
</tbody>
</table>

Semester Courses: Number of courses needed based on a semester system. For a quarter system, 2 semester courses are equivalent to 3 quarter courses. The unit value of these courses will generally vary from 3 to 5 depending on traditional course design.
REFERENCES


34. Greene JB, Nuzum DS, Boyce EG. Correlation of pre-pharmacy work experience with performance in a Top 200 Drugs course. Submitted but unpublished.