EVIDENCE-BASED ADMISSIONS: CORRELATES OF STUDENTS' ACADEMIC SUCCESS IN VETERINARY MEDICAL SCHOOL

By

Hilda Mejia Abreu

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ABSTRACT

EVIDENCE-BASED ADMISSIONS: CORRELATES OF STUDENTS' ACADEMIC SUCCESS IN VETERINARY MEDICAL SCHOOL

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Literature on the admission criteria and processes related to academic success of professional students at any of the twenty-eight veterinary medical schools in the United States is limited and research on what predicts students' academic success has not been regularly examined (Pappaioanou, 2010). The current study investigated the extent to which traditional academic characteristics (i.e., cumulative grade point average, science grade point average, and graduate record examination scores) and non-traditional student characteristics (i.e., communication and interpersonal skills, the essay or self-assessment survey, prior knowledge of the profession, and community service as assessed via the interview process) predicted students' academic performance at Michigan State University (MSU) College of Veterinary Medicine (CVM). Several analyses were performed to determine the contribution of traditional and non-traditional factors as predictors of students' academic performance in veterinary medical school as measured by their grade point average in the veterinary school program at two points: (a) the completion of the didactic portion of the curriculum (the first five semesters) and (b) the completion of the clinical portion of the curriculum (the last four semesters).

The interpretation of the results yielded significant findings in several areas: (a) the identification of characteristics of traditional and non-traditional students that were predictive of academic performance in the veterinary school relative to students' cumulative grade point average in the clinical and didactic portion of the curriculum; (b) the identification of traditional academic characteristics that were predictive of student placement status of academic probation;

and (c) support for the expectation that the cumulative didactic grade point average was predictive of the cumulative clinical grade point average. Through the identification of variables related to both traditional and non-traditional characteristics, variables that were predictive of students' academic performance in one veterinary school, administrators at other programs for health care professional programs may be encouraged to review and evaluate the strength of their admission criteria to ensure the reliability and validity of their applicant selection processes.

DEDICATION

To my father, Octavio Mejia Flores and my mother, Catalina Reynoso. They both instilled in me the importance of education while providing much love and support.
To my husband, Scott Burgess who has adjusted his entire life and career to support me during this journey. Your support, love, and devotion made this dissertation possible.
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CHAPTER 1

INTRODUCTION

Members of professional program admission committees in the health professions have an important task as they select future health care providers (Latif & Dunn, 2004; Peskun, Detsky & Shandling, 2007). The task of selecting students who will become the best, brightest, most competent, most ethical, and most caring health care providers is a sensitive, delicate, time-consuming, and important activity in professions such as medicine, nursing, veterinary medicine and dentistry as these individuals are responsible for the well-being of patients, the protection of the public, and the reputation of their chosen profession (Lewis & Klausner, 2003).

According to the North American Veterinary Medical Education Commission's (NAVMEC) summary of findings, in addition to the important responsibility of the schools' selecting exceptional future health care providers, it is expected that veterinary medical graduates achieve competency in three areas: (a) multispecies knowledge plus clinical competence in one or more species or disciplines; (b) "One Health" professional competency related to the intersection of animal, human and environmental health; and (c) the development of professional competencies. Therefore, admission selection criteria and academic curricula are interrelated and must be aligned to address the needs of the profession and accreditation requirements to "implant changes that allow new graduates to have the knowledge and competencies society needs" (NAVMEC, 2011, p. 23). Further, it is stated within Standard 7 of the American Veterinary Medical Association's (AVMA) Council on Education (COE) that "factors other than academic achievement must be considered for admission criteria" (AVMA, 2012, p. 34). The AVMA-COE's Standard 9 (concerning curriculum) goes on to state that

effective communication shall be provided to professional students as part of the veterinary medical school curriculum.

Admission and accreditation are critical to the assessment of outcomes for professional veterinary medical students. The veterinary medical schools' accreditation process speaks to the importance of outcomes. Therefore, this study's primary focus is to identify characteristics of prospective students that contribute to successful academic performance at MSU CVM. In addition, the study examined the relationship between traditional admission criteria and non-traditional criteria and students' academic success in veterinary school. Selecting prospective students for any professional program admission based on known factors of academic success remains a difficult process, and performing the role of admission committee chair or member has been one of the most important responsibilities that program administrators, faculty, and staff accept during their careers. Of further concern related to program admission decisions is the knowledge that students, schools, and states bear the cost of admission mistakes when students are unsuccessful because they do not fit within the institution or program due to faulty selection criteria (Vickers & Reeve, 1990). The importance, responsibility, and sensitive nature of selecting the best, most capable, most caring, and most responsible future health care providers, necessitates that admission selections procedures be regularly reviewed and updated at U. S. schools which educate health care professional programs (Best, Diekema, Fisher, & Smith, 1971).

The literature on selection processes or admission criteria varies across veterinary schools. For example, of the nation's twenty-eight veterinary schools, some schools focus primarily on traditional selection methods such as grade point average (GPA) and standardized test scores (STS) while others use a combination of indicators, such as GPA and STS along with

personal interviews (Association of American Veterinary Medical Colleges (AAVMC), 2011; Ottinger, 2011). Interestingly, the reviewed literature is more expansive in the area of admission selection processes for allopathic medicine and dentistry as it relates to admission criteria, selection methods used, and academic performance. Therefore, the assessment of students' academic performance in veterinary professional programs is essential to determine which selection criteria, processes, and methods are most useful and appropriate for predicting academic performance. Further, the assessment of selection methods on a regular basis is a known best practice (American Association of Collegiate Registrars and Admissions Officers, 2011) and neglecting this practice could have a negative impact on the outlined goals of both programs and professions.

Most professional health care programs (e.g., allopathic medicine, veterinary medicine, nursing, and dentistry) in the United States traditionally use academic data, which are often identified at the undergraduate level by grade point average in subject areas relevant to the professional program (e.g., natural science courses) and at the graduate level by standardized tests such as the Medical College Admissions Test (MCAT) or the Graduate Record Examination (GRE), to select candidates for admission (AAMCAS 2011; Ottinger, 2011). Despite this frequent use of traditional academic data, Zwick (2002) argues that scores gathered from standardized tests are incomplete, subject to error, and provide little information about the knowledge of assessed individuals. Furthermore, admissions deans at professional schools have identified standardized exams as a significant barrier to college entrance for first-generation college students, women, and minorities (Rooney, 1998). As Zwick (2002) observes, other critics of standardized tests argue the tests offer only limited evidence about any given person's capabilities. Further concerns about the reliability of traditional criteria for admission to

professional programs include challenges to using grade point average because grade inflation is widespread at many academic institutions (Mansfield, 2001), thus artificially inflating the assessment of the cognitive abilities of many prospective students. Others have argued that little variability in test scores occur for students entering some programs such as medical school because program admission is often highly competitive and applicants are likely to be at the top of the potential range of scores and likely to do well in their medical school training, and the limited variability in test scores or grade point average makes selection of top candidates difficult, at best (Ferguson, James, & Madeley, 2002; Sedlacek, 2004). Similarly, Deary, Der, and Ford (2001) found strong evidence supporting the need to use diverse measures of cognitive ability to best assess general intelligence due to the challenges presented by grade inflation and minimal variability of testing scores across programs, and to the need to include non-traditional characteristics in selection criteria if a "best program fit" for academic success was to be achieved.

Educators, researchers, and deans who have proposed utilizing traditional measures (cognitive) and non-traditional measures (non-cognitive) to select appropriate student populations for their programs of study also want to see evidence of whether combined selection processes, criteria, or methods at one school can yield a suitable student who would be accepted across similar institutions (Astin, 1993; Sedlacek, 2004; Tinto, 1975, 1993; Tracey & Sedlacek, 1984; Washington, 1996). These institutions describe a suitable student as one who represents "goodness of fit" within the institution's academic and non-academic environment and as one who is able to successfully navigate and complete the program of study.

The combination of traditional and non-traditional attributes is seen as providing a holistic review of applicants' credentials, a strategy that might better forecast a student's

successful academic performance in a professional program (Sedlacek, 2004). Incorporating non-traditional attributes with traditional attributes as selection criteria could also provide useful data for professional school selection methods because a variety of assessment strategies can be included in the course of admission selection process. Although non-traditional components (e.g., cultural competency, assessment of communication and interpersonal skills) have been used in admission selection processes for professional programs, little research exists as it relates to the use of these components specifically in veterinary medicine (Lee, Vaishnavi, Lau, Andriole, & Jeffe, 2007). In the study entitled "The Current and Future Market of Veterinarians and Veterinary Medical Services in the United States," often referred to as the KPMG study or the Mega Study, which was designed to assess whether veterinarians are meeting the needs of the profession, Brown and Silverman (1999) found that practicing veterinarians were lacking in positive interpersonal and communication skills. These findings support veterinary medical school administrators' and deans' discussions about combining traditional and non-traditional selection criteria and methods that would address characteristics such as skills, knowledge, attitudes, and aptitudes desired of future veterinarians (NAVMEC, 2011).

Statement of the Problem

The veterinary profession continues to grow as more schools are created and more students are enrolled (AAVMC, 2011). Since 2005, four new veterinary schools have been established—one in the United States, one in Canada, and two in the Caribbean. While the addition of four schools might not appear to be a large number, the last veterinary school prior to this 2005 expansion was created in the 1970s; therefore, for the veterinary profession, four new schools represent a significant expansion. With new schools being developed and the expense and time-consuming preparations needed to inaugurate a new, credible veterinary program,

determining valid and reliable criteria for new-student enrollment is of paramount concern. Providing additional guidelines to identify pertinent student characteristics predicting program success in a veterinary medicine program will be useful to schools. Further, results from the current study could provide new veterinary schools with identified characteristics of students who can succeed academically in a veterinary curriculum (Ottinger, 2012). Moreover, most of the research relative to academic success has focused on undergraduate education and in other professional fields. The time is appropriate for veterinary education professionals to identify characteristics that influence academic performance.

Gaining admittance to one of the few established veterinary schools in the country is a prestigious accomplishment given that there are over 5000 applicants for approximately 2000 positions (Ottinger, 2012). Further, academically successful veterinary school graduates with exceptional performance are actively pursued by prestigious internships and residency programs, and these opportunities along with employment by major veterinary and corporate clinics are highly competitive in nature (Brown & Silverman, 1999; NAVMEC, 2011). As a result, the selection process, with clearly defined and tested criteria and methods, should be completed with the utmost confidence. Given the importance of accomplishing this goal, academic and non-academic abilities plus a determination of prospective student "fit" with the environment must be included in all program admission selection processes. The process of identifying a student's fit to the institution is referred to in the industry as "ethical admission selection." It is important for schools to know which characteristics predict and positively influence academic performance and graduation rates to ensure success in the highly competitive post-graduation world of employment, internships, and residency programs.

Purpose of the Study

The purpose of this study is to identify characteristics defined within an applicant pool of prospective students that predict academic performance in veterinary school. After more than four decades of research and supporting evidence in allopathic medicine, Adams and Frankle (2007) demonstrated that non-traditional student characteristics (i.e., communication and relationship building) influenced the quality of care outcomes, which, in turn, affected both academic success during program enrollment and professional success after graduation. It is critical for veterinary medical education to incorporate traditional and non-traditional characteristics to predict academic success during the didactic and clinical years. Since allopathic medicine has successfully used traditional and non-traditional characteristics to select future health care providers and veterinary medicine programs are not so different from allopathic medicine, it seems reasonable for veterinary medical schools considering applicants to incorporate both types of characteristics to identify variables predicting students' academic success during the didactic and clinical years.

Rationale

Since the founding of the first veterinary school in Lyon, France in 1761, veterinary medicine has evolved. In the United States, veterinary medicine practice started during colonial times and developed as a formal profession with the establishment of the University of Pennsylvania Veterinary School in 1883. During the 1950s, people who worked with animal diseases started to be called veterinarians. The profession is respected, and the number of veterinarians in the United States has grown due to demands for services (AVMA, 2012). Further, the profession experienced increasing demands for services in the 1980s and 1990s, and there was a greater need for well-educated veterinarians to meet society's needs as the number of

pets per household grew (AVMA, 2007). Furthermore, excellent care from a veterinarian with technical and non-technical skills is expected. Thus, there are a number of reasons to explore the topic of finding appropriate criteria, processes, and methods to select veterinary applicants for admission that predict academic success: (a) an identified gap in the literature with respect to variables that predict academic success in veterinary school, (b) findings from the broad KPMG study challenging institutions to revamp procedures, (c) NAVMEC Roadmap (2011) recommendations, (d) the scholarship of evidence in admission selection practices, (e) a professional curiosity to identify whether changes in admission selection criteria and strategies have an influence on the type of student selected and their academic success during didactic and clinical curriculums, and (f) the need to share findings and implications from selected criteria and methods with the Michigan State University College of Veterinary Medicine (MSU CVM) at which this study was conducted. To these ends, the current study investigated the diverse selection criteria and methods adopted at one veterinary medical school as predictors of academic success.

Significance

Limited research exists that provides evidence about successful academic performance by prospective veterinary students based on the selection method, processes, and criteria used at the time of admission. Therefore, this initial endeavor using prospective student characteristics that predict academic success throughout the program of study taken at routine times of program review could provide a foundation for others to consider when conducting further studies. From this foundation of knowledge, veterinary medical school programs could then individualize their selection of additional prospective student characteristics to provide the “best fit” with institutional and program statements (i.e., mission, vision, and goals) and the variety of

environments (i.e., geographic, psycho-social, or economic) known to influence student satisfaction and program progression. The use of known traditional and less-familiar non-traditional student characteristics should expand the likelihood of finding predictors of academic success. Furthermore, a review of those characteristics that are shown to positively influence successful academic progression but are not statistically strong enough to predict the desired study outcome could, nevertheless, provide useful additional criteria for inclusion in admission selection decisions. In addition, those characteristics of prospective students that were identified in the literature as relevant to academic success but were not found to be predictors of academic performance in this study could also provide valuable information for further consideration. Finally, the use of two distinct points of data collection across seven cohorts of students provided information regarding predictors of academic success for both didactic and clinical components of the curriculum.

Research Questions

1. To what extent do traditional and non-traditional admission characteristics contribute to the prediction of cumulative grade point average (GPA) in the didactic portion of the veterinary medical school curriculum?
2. To what extent do traditional and non-traditional admission characteristics contribute to the prediction of cumulative grade point average in the clinical portion of the veterinary medical school curriculum?
3. To what extent does cumulative didactic GPA contribute to the prediction of cumulative clinical GPA in the veterinary medical school curriculum?
4. Do group differences exist between students placed/never placed on academic probation in terms of admission characteristics or academic performance?

Definitions

The following terms are used throughout this study:

1. Academic performance: A person's level of academic achievement in a professional program of study as measured by GPA.
2. Academic Success: Continued, expected progression in both the didactic and clinical portions of the veterinary school curriculum.
3. Didactic Curriculum: The portion of the curriculum composed of lectures.
4. Clinical Curriculum: The portion of the curriculum that includes patient care and work with the heath care team.
5. Student Performance Committee: The organization responsible for the evaluation and recommendation of students who find themselves in academic difficulty.
6. Traditional (cognitive as well as technical) Characteristics: Grade point average, science grade point average, Medical College Admissions Test score, and Graduate Record Examination score.
7. Non-traditional (non-cognitive, social, as well as non-technical) Characteristics: Personal statement, interview score, evaluation or reference letters, types and quantity of community service, interpersonal and communication skills, volunteer activities, knowledge of the profession, work experience, successful leadership activities, and knowledge of self.
8. Criteria: Individual traditional and non-traditional student characteristics that are assigned a numerical value for the purpose of measurement or statistical analysis.
9. Process: A series of progressive, decision-making phases that culminates in the selection of qualified applicants for program enrollment.

10. Method: A variety of traditional (i.e., standardized test score or GPA) and non-traditional activities (i.e., personal interview or essay review) that provide information about prospective applicants for consideration during the program admission decision-making process.

Assumptions

The following assumptions guided the initial design of this study:

1. Admissions personnel across all professional programs have an ethical responsibility to select qualified students believed to be capable of academic success within their program of study.
2. There is a critical need for veterinary medical school admission personnel to identify prospective student characteristics that predict academic success.
3. The use of traditional and non-traditional characteristics provides an opportunity for holistic assessment of applicants to predict academic success in veterinary medical school.
4. Prospective student characteristics that are predictive and positively influence academic performance and success are useful criteria for inclusion in program admission selection processes within the veterinary program of study and possibly others.
5. Data are presumed to be accurate and complete for study cohorts.
6. The sample of approximately 600 veterinary students is presumed to be a representative sample of veterinary students in the country because there are twenty-eight veterinary schools in the United States and the applicant pool is known to be very homogenous as it relates to applicants and enrolled student characteristics of GPA, gender, background, and preparation.

Disclosure

The researcher was Assistant Dean for Admissions and Student Services at the veterinary school in question at the time that students were being admitted.

Frameworks and Related Concepts

Astin's (1993) I-E-O model and Sedlacek's (2004) non-cognitive variables framework, viewed as seminal works within the reviewed literature (Amey & Long, 1998; Cress, Astin, Zimmer-Oster, Burkhardt, 2001) were used as conceptual underpinnings to guide the study design.

Summary

Current opportunities in veterinary medicine are a product of results from the KPMG study. The study by Brown and Silveman conducted in 1999, urged the veterinary profession to select as future veterinarians students who possess technical and non-technical skills to serve the community in their capacity as health care providers. According to the study, the solo practitioner was vanishing and practices were changing to include a health care team approach (Brown & Silveman, 1999). Thus, the finding proposed challenges to identifying a different kind of veterinary student. While few studies have focused on the long-term predictive validity of non-cognitive characteristics such as experience, interest, biographical data, and personality variables (Lievens, Ones, & Dilchert, 2009), there have been many studies relative to cognitive predictive values.

In this chapter, I presented the background in brief for the study, the problem statement, the purpose of the study, and its rationale and significance. Additionally, I presented information concerning the need for conducting this research. Finally, Astin's (1993) I-E-O model and Sedlacek's (2004) non-cognitive variables were briefly introduced as the frameworks

underpinning this research. Astin's model was designed to study the influence of the undergraduate environment on retention and persistence and has been used to analyze the environmental effects of school on graduate and professional students (Gore, 2009). Sedlacek's non-cognitive variables framework has been used to analyze the degree to which non-traditional attributes influence academic success of various populations. In the next chapter, the literature for this study is discussed.

CHAPTER 2

LITERATURE REVIEW

This research study examined which variables influence veterinary medical school students' academic success. The conceptual frameworks that guided this study were Astin's (1993) input, environment, and outcomes (I-E-O) model and Sedlacek's (2004) non-cognitive variables (NCVs). A brief background on Sternberg's (1985) Triarchic Theory of Intelligence is included here as the foundation for development of Sedlacek's NCV work. Astin's I-E-O model and Sedlacek's work are illustrated using findings from the literature related to research into the application of these frameworks to undergraduate and professional students' academic success. A review of admission selection processes at Michigan State University (MSU) College of Veterinary Medicine (CVM) and an outline of the veterinary medical school curriculum can be viewed in Appendix A and Appendix B, respectively. Finally, this chapter concludes with a review of available literature related to professional programs admission, selection, committee members' work, and the characteristics valued in the process as they relate to components impacting students' academic success.

Conceptual Frameworks

This section describes the conceptual frameworks used in this study to identify predictors of students' academic success at a veterinary school. Astin's I-E-O model (1993) and Sedlacek's (2004) NCV framework served as the conceptual and data analysis frameworks for this research study. Astin's I-E-O model was conceptualized to show the influence of college on undergraduate students. Sedlacek's NCVs were identified to show the influence of non-academic variables on students' academic success in college. This research study examined the

influence of variables at admission on veterinary medical school students' academic success. Next, each conceptual framework is reviewed in greater depth.

The I-E-O Model. This research study used Astin's (1993) input, environment, and outcomes (I-E-O) model as one of the two conceptual and data analysis frameworks. Astin's model shows which input variables (i.e., traditional and non-traditional components at admission) have an impact on the outcome variables in this study (i.e., students' academic success in the didactic and clinical curriculums). Student characteristics (inputs) and participation in activities at college (environmental factors) play important roles in shaping the outcome of a student's college career (e.g. college GPA, graduation). Astin's I-E-O model allows researchers "to produce information on how outcomes are affected by different educational policies and practices" (Astin, 1993, p. 37). Academic success in college has much to do with students' input at entry and with the environment a college creates for its students to live and study in.

Astin's I-E-O model is comprised of three parts: (a) input measures, (b) environmental measures, and (c) outcome measures (see Figure 1). College students bring input measures or variables at entry such as GPA, STS, their performance during an interview, and their knowledge of self. Environmental measures refer to aspects and events that occur during the educational program such as curriculum, support, and culture of the program. The outcome measures, as defined by Astin, can be (a) cognitive and (b) affective. Cognitive measures are related to reason and logic while affective measures involve attitudes and feelings.

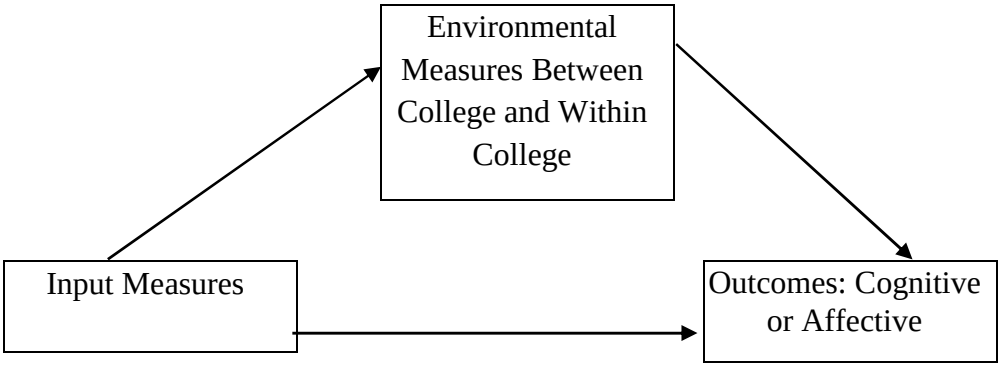


Figure 1. Astin's (1991) I-E-O Model

To date, Astin's I-E-O model has not been applied to veterinary medical school students to determine which specific inputs at admission have an influence on a student's academic success. This study tested Astin's model on the veterinary medical school student population at MSU CVM and examined for several input variables that are included as pre-veterinary school attributes such as science GPA, cumulative GPA, GRE scores, interviews, and information from file review scores. All inputs, or experiences brought with admitted students, were considered to determine the degree to which specific variables had an impact on students' academic success in school. For this study, the input variables consisted of data about academic achievements completed prior to entering veterinary medical school.

Input. Inputs "refer to the characteristic qualities a student brings initially to the educational program (including the student's initial level of developed talent at the time of entry)" (Astin, 1993, p. 18) and include both academic and non-academic experiences. Examples of inputs can be educational background, rationale for selecting a particular institution or profession/field, life goals, gender, ethnicity, preparation for the course of study, life experiences, and reason for attending college (Astin, 1993). Assessment of non-academic

components, communication, and interpersonal skills provides information to administrators about the range of assets applicants possess at time of admission.

Environment. Environment as defined by Astin (1993) is created at the institutional level and includes, among other aspects, policies, pedagogical approaches, faculty, courses, teaching, friends, events, activities, and the institutional climate. Astin (1993) postulates that if the input is aligned with the environment, students will be engaged and find the institution relevant to their goals. At MSU CVM, faculty and staff recognized the importance of the various skills, knowledge, attitudes, and aptitudes veterinary students must possess at entry to fit in with the environment. It was important, therefore, for members of the admission committee to identify applicants who were prepared to interact with the community of scholars at MSU CVM.

Outcomes. Outcomes "refer[s] to the 'talents' we are trying to develop in our educational program" (Astin, 1993, p. 18). Outcome measures are evaluated in this study as they relate to performance in the veterinary program. Performance at MSU CVM is measured by grade point average in both the didactic and clinical portions of the curriculum. The study did not assess performance after graduation as post-graduate performance is most often related to veterinary licensing examinations and work satisfaction.

The outcomes of interest for this research study were students' veterinary medical school GPA at two points: (a) at the completion of the didactic curriculum (five semesters) and (b) at the completion of the clinical curriculum (four semesters). As Astin's I-E-O model has previously been used to study graduate students and faculty involvement (Barger, 2010; Gore, 2009), it was chosen to be one of the frameworks to study veterinary medical students' academic success for seven cohorts admitted from 2000 through 2006 at MSU CVM.

Sedlacek's Non-cognitive Variables. The foundational work of Sedlacek's (2004) non-cognitive variables was selected as the second conceptual framework in this study to assess non-traditional variables used at admission at a veterinary medical school to determine their influence on students' academic success. Sterngberg's (1985) Triarchic Theory of Intelligence was the basis for Sedlacek's work in non-cognitive variables' work. Non-cognitive variables are affective variables such as the description of feelings, perception, and are subjective in nature. They differ from cognitive variables in that cognitive measures are defined as specific test scores or specific grades.

According to Sedlacek (2004), three types of intelligence were suggested by Sternberg (1985), for which some theoretical and empirical support was provided (see Sedlacek, 2004). These types of intelligence are defined by Sternberg as (a) componential, (b) experiential, and (c) contextual. Sedlacek (2004) describes componential intelligence as the ability to interpret information hierarchically and taxonomically. People who perform well on standardized tests are identified as possessing componential intelligence. Experiential and contextual intelligences are related to interpreting information in changing contexts and to the ability to adapt. Standardized tests do not measure these two types of intelligences; they measure componential intelligence instead. Sternberg (1985) is a proponent of evaluating intelligence in a comprehensive way.

In response to Sternberg (1985), who advocates for adding non-cognitive variables to purely cognitive variables to improve the overall prediction of academic success and persistence, Sedlacek (2004) identifies and describes non-cognitive variables as non-intellectual aspects, such as self-concept, motivation, personality of a student, and environment that influence learning. Further, Sedlacek (2004) identifies non-cognitive factors that influence learning as non-

intellectual components; these factors include a realistic self-concept, motivation, and a student's personality. Sedlacek (2004) cites several works which earlier identified a number of non-cognitive variables as useful predictors of academic performance; these variables include personality (Brown, 1994), self-responsibility (McConatha, 1990), self-concept (Johnson, 1993), academic self-concept (Gerardi, 1990; Johnson, 1993), locus of control (Kanoy, Wester, & Lata, 1989), expectations and self-expectancy (Haynes & Johnson, 1983; Trippi & Stewart, 1989), and self-efficacy (Schunk, 1991). Several studies have shown non-cognitive variables to be more accurate predictors of academic success for minority students (e.g., Sedlacek & Adams-Gaston, 1992; Tracey & Sedlacek, 1984, 1987; Wawrzynski & Sedlacek, 2003). Woods and Sedlacek (1988) also supported the position that non-cognitive variables were related to particular aspects of academic success among minority students. Sedlacek and Brooks (1976), Tracey and Sedlacek (1984), and Sedlacek (2004) proposed eight non-cognitive variables as useful to predict academic success.

Sedlacek's non-cognitive variables model was developed using more than thirty years of research and practice. From this experience, Sedlacek (2004) demonstrated that measures currently available to assess componential knowledge have been poor predictors of academic success for racially diverse and cultural groups. His research findings on standardized tests suggest that minorities and women tend to perform poorly on these measures. Additionally, Sedlacek postulated that "test results might not suggest any developmental actions. Little or no research supported many of the measures available" (2004, p. 35).

Non-cognitive variables relate to adjustment, motivation, and perception, instead of cognitive abilities as determined by grades and test scores (Sedlacek, 2004). They also evaluate attributes people possess and have been recognized for years by scholars. Goldberg (2001, cited

by Sedlacek, 2004) asserted that non-cognitive variables are personality traits. In Goldberg's research, the personality traits identified were (a) extraversion, (b) agreeableness, (c) consciousness, (d) emotional intelligence, (e) intellect and (f) imagination. In identifying non-cognitive variables, Sedlacek also considered Sternberg's (1985, 1986, 1996) experiential and contextual domains.

According to Sedlacek (2004), non-cognitive variables can be assessed in a number of ways. One way is the Non-Cognitive Questionnaire (NCQ), several forms of which were developed and employed in a variety of admission contexts. The NCQ can also be administered online or adapted to an interview format. Tracey and Sedlacek (1984) "reported two-week test-retest reliability estimates on NCQ scores ranging from .74 to .94, with a median of .85 for the NCQ items with differing samples" (p. 49). Additionally, the NCQ has been used to select for the Gates Millennium Scholars program and the eight non-cognitive variables were assessed using short essay answers. Applications for the Gates Millennium Scholars were rated and inter-judge agreement was found for raters (Pearson r = .83). Further, Cronbach's alpha for all raters in 2001 was .92 (Sedlacek, 2004).

The eight non-cognitive variables identified by Sedlacek (2004) are outlined below.

1. Positive Self-Concept: A successful individual feels confident in his or her ability to graduate regardless of obstacles that may arise. The individual expects to do well in both academic and non-academic areas and makes positive statements about him- or herself and assumes an ability to handle any challenges that may come his or her way. There is a high level of self-efficacy and self-esteem. According to Sedlacek (2004), "positive self-concept is predictive of success in higher education for students of color and other non-traditional students. Having a good self-concept is important for any student, but it becomes even more so for those

with non-traditional experiences because of the added complexity of dealing with a system that was not designed for them" (p. 39). Further, positive self-concept was predictive of grades for international students (Boyer & Sedlacek, 1989).

2. Realistic Self-Appraisal: The individual is able to recognize and accept background academic deficiencies while working toward improvement. The individual recognizes criticism or rewards as logical consequences of performance. According to Sedlacek (2004). realistic-self appraisal is the "ability to assess one's strengths and weakness, allowing self-development" (p. 41). Further, Perrone, Sedlacek, and Alexander (2001), "found that White and Asian American students perceived intrinsic interest in a field as the major barrier to achieving their career goals, suggesting that they were not so interested in the fields they were studying as were other students" (cited in Sedlacek, 2004, p. 41). Tracey and Sedlacek (1984) found that realistic self-assessment positively correlated with college grades, retention, and graduation for all students.

3. Understands and Deals with Racism: The individual has a realistic view of racism based on personal experience and understands the role of the system in his or her life and how the system impacts minority individuals. The individual has developed a method of assessing and responding to cultural or racial demands. Similarly, the individual does not blame others for his or her own struggles and reacts to injustice when appropriate.

4. Preference for Long-Range Goals to Short-Term or Immediate Needs: The individual sets goals and progresses in a timely manner without reinforcement. The individual is able to exhibit patience and accept partial fulfillment of a longer-term goal over a period of time. The individual has a future and a past orientation allowing him or her to look beyond the immediate situation to the benefits of planning for long-term academic and non-academic goals. Astin

(1975) noted that African Americans with lower aspirations were more likely to leave college than were members of other groups with higher aspirations and established goals. In addition, Tracey and Sedlacek (1984) were able to provide evidence that long-range goals impacted grades, retention, and graduation of students.

5. Availability of a Strong Support Person: The individual is able recognize the need for help and is willing to ask for it. The individual has identified at least one other person who provides support and encouragement on a regular basis. The individual also recognizes the difficulties inherent in being a loner and rarely relies solely on his or her own resources to address problems.

6. Successful Leadership Positions: The individual has experience in leadership positions and has influenced and assisted others in both academic and non-academic situations. The individual is comfortable providing advice and mediation to peers. Similarly, the individual has no problem taking appropriate action when a situation called for action.

7. Demonstrated Community Service: The individual identifies with a cultural, geographic and/or racial group that has a specific and long-term relationship within the community. Similarly, the individual has a history of involvement in community-based activities and/or organizations that have accomplished specific goals in the community setting.

8. Knowledge Acquired in a Field: The individual has non-traditional, culturally and/or racially based experience and knowledge regarding a field or area that may or may not have been formally studied in school. Also, the individual has developed innovative and creative ways in which to acquire information about a particular area.

There is evidence demonstrating that retention and graduation is correlated to strong NCVs (Boyer & Sedlacek, 1989; Sedlacek, 2004; Tracey & Sedlacek, 1984). Furthermore,

research by Rogers (1984) and Washington (1996) supported the use of non-cognitive variables in addition to cognitive components to predict the academic success of some students in college.

The Admission Process

This section includes a review of the literature on admission practices drawn from the available literature about undergraduate, veterinary medicine, allopathic medicine, and pharmacy programs. The current processes for selecting professional school applicants are discussed. Next, the characteristics admission officers consider for selecting applicants for professional schools is given. A background discussion on veterinary schools admission selection methods and professional schools selection characteristics is presented, and a general discussion of non-traditional characteristics in admission to professional schools is given. Finally, the literature as it relates to students' academic success, and challenges and limitations when using non-traditional characteristics in admission selection practices is considered.

In the health care fields, there are various elements that seem to influence students' academic success while in a program of study. However, there is little to no agreement among scholars or practitioners as to which specific variables determine students' academic success and, therefore, should be accounted for at entry to professional schools. Traditional selection methods such as grade point averages and standardized test scores predict performance during the didactic curriculum but tend to be poor indicators of clinical curriculum performance. As Hughes (2002) reminds us, admissions "selection is not an exact science but we must use what evidence we have to ensure that we do our best by all concerned" (p. 18).

There is disagreement in the field about the extent to which strong academic preparation contributes to the success of a veterinary medical school graduate. In addition, practitioners and educators increasingly recognize the value of strong interpersonal skill in that success. As

suggested by Levetown (2008), “health care communication is a skill that is critical to safe and effective medical practice; it can and must be taught” (p. 1). And, according to Lewis and Klausner (2003), clearly, technical as well as non-technical skills are critical to the success of veterinary practitioners.

Admission committees for health care programs face the difficult task of selecting applicants with potential for success in the curriculum and clinical rotations who will meet the needs of patients/clients and the profession once in practice. To begin with, veterinary education is expensive, and, therefore, accurate selection and admission decisions can help minimize educational costs by decreasing the proportion of dropouts (Brown & Silverman, 1999). On the other hand, veterinary education is the professional training needed to acquire knowledge and skills that will enable individuals to perform their jobs (Lloyd, King, Maccabe, & Heider, 2004). However, unless there is a method to assess non-traditional components during applicants’ selection, admission officers and committee members may find themselves unable to determine whether applicants to health care professions possess these important skills.

Veterinary Medical School Admission

Veterinary Medical School (VMS) admission officers and committee members seek to select students who are most likely to be most successful at their institutions. Research related to the selection of applicants at colleges and universities in the United States has, for the most part, focused on traditional components to predict success while in college. Typically, most colleges select applicants for their undergraduate degrees based on some combination of academic records, high school GPA, class rank, and the Scholastic Achievement Test (SAT) or Academic Collegiate Test (ACT) (McGinty, 1997). The process used in the admission of applicants to

advanced degree programs such as veterinary medical school is similar to that used at the undergraduate level.

Veterinary medical schools (VMS) use traditional academic components as a way to predict which applicants have the best chance of being successful in veterinary school, and research that has examined the medical school admission process suggests that undergraduate GPA is the strongest predictor of admission decisions (e.g., Montecinos & Pohlmann, 1987).

Abundant research (e.g., Confer, 1990; Confer & Lorez, 1999) has provided support for the use of traditional components in selecting applicants and has been heavily relied upon at VMSs and in other programs because previous GPAs and STSs have relatively high criterion-related validities with future GPAs (Hezlett et al., 2001). Moreover, pre-veterinary grades are viewed as the best predictor of success in a veterinary medical student's pre-clinical years (Chastain, Horrell, & Seay, 2007). To date, however, very little research has explored predictive variables during the clinical years.

Empirical evidence suggests, however, that grades are not the sole predictor of performance in college and post-graduation work. There is an ongoing debate about whether decisions based on GPA and standardized tests provide a basis for fairness and equality in the evaluation of applicants (Sedlacek, 2004). For example, Sedlacek (2004) suggests, "Even though it may seem logical to *hope* that a single standardized test could fairly equate applicants, *expecting* such an outcome is unreasonable" (p.60). Over the past two decades, veterinary medicine school administrators have found themselves wrestling with challenges related to characteristics that might be assessed at admission (input) that may be predictive of students' academic success in didactic and clinical curriculums (outcomes). According to Sedlacek (2004), "standardized tests fall short when predicting (a) grades beyond first year for any student,

(b) retention or graduation for any student, and (c) grades or retention for students of color and women" (p.61).

Contributing to this debate, Chastain et al. (2007) claimed that in addition to pre-veterinary grades, factors such as the ability to communicate, to work in groups, and problem solve also influence future academic success. They further argued that grades are not enough to predict success as a professional veterinarian. During the didactic portion of the curriculum, grades and standardized test scores have been shown to play a significant part in predicting grade point average. The clinical portion of the medical school curriculum, however, demands that students possess the ability to communicate with clinicians, members of the health care team, clients, and other stakeholders, which often cannot be evaluated from grades or standardized tests.

In a longitudinal study of 627 medical students, Lievens et al. (2009) demonstrated that extraverted, agreeable, and conscientious medical students in Belgium tended to obtain lower GPAs in the preclinical medical school curriculum. However, later in medical school, such personality traits (e.g., conscientiousness, agreeableness, extraversion, openness, and emotional stability) were positively—and more strongly related—to clinical performance. They further suggested adding the assessment of personality traits to the medical school entrance requirements to predict which students would be successful. To support the need for evaluations based on non-traditional components in health care programs, in 2012, the Association of American Medical Colleges (AAMC) adopted a new MCAT to assess for social and behavioral traits (Jaschik, 2011).

Non-traditional skills have been suggested to have a strong relationship with a medical student's clinical performance. For example, though communication skills, leadership ability,

and interpersonal skills are not directly correlated with performance during the didactic curriculum, it is suggested that they are critical qualities in the development of a successful clinical student (Meredith, Dunlap, & Baker, 1982; Murden, Galloway, Reid & Colwill, 1978). According to Lievens et al. the results of their longitudinal study have implications for practice:

> Performance in professional education (e.g., law, business, administration, pharmacy, medical school) over the years becomes less reliant on the acquisition of declarative knowledge and incorporates more strongly interpersonal and motivational qualities. Admission to professional education cannot be based on only one type of predictor or on maximizing one type of criterion. (p. 1528)

Indeed, applicants to veterinary school with a combination of traditional and non-traditional characteristics might yield the type of veterinary practitioner the profession is seeking. However, few empirical studies have determined the extent to which non-traditional skills assessed at the admission point have any relevance to students' academic success in veterinary medical school.

Veterinary medical schools (VMS) prepare graduates with the technical knowledge necessary for success in practice (Lewis & Klaussner, 2003). Undoubtedly, the technical preparation and capabilities in this particular health care field are important. The literature, however, suggests that veterinary medical school graduates are lacking non-technical skills that are also valuable in successful practices (Brown & Silverman, 1999; Lewis & Klaussner, 2003). Because the veterinary curriculum is demanding, overloaded, and rigorous, teaching non-traditional components (e.g., interpersonal and communication skills) as part of the veterinary curriculum is difficult. Rather, it may be more efficient and advantageous for admission professionals at VMSs that do not currently include NCVs in their admission selection process to

adopt selection practices that include the assessment of these characteristics (Brown & Silverman, 1999; Lewis & Klaussner, 2003).

Researchers such as Chuck (2008) and Tracy & Sedlacek (1984) have noted that students in minority populations who possess these non-technical skills are successful and engaged in various academic curricula in their selected professions. In contrast, others argue (e.g., Bridgeman, McCamley-Jenkins, & Ervin, 2000; Hezlett et al., 2001) that, as a whole, both GPA and STSs have predictive validity in determining a variety of academic performance outcomes. Indeed, the standard variable for predicting first year performance in VMS is STS (Confer, Turnwald, & Wollenburg, 1999), but this is a one-dimensional, easy, and convenient way to assess applicants (Sedlacek, 2004).

The Veterinary Medical School Curriculum

For the purpose of this study, some general background about veterinary medical school curriculum is highlighted. Information about the veterinary medical school curriculum and how it interfaces with admission practices and accreditation is presented.

Veterinary medical school curricula are not the same across the twenty-eight American institutions educating future veterinarians (AAVMC, 2011). The duration of veterinary medical school programs around the world is anywhere from three to six years, but, in the United States, they are usually four years in duration (at MSU CVM, the four years include summer sessions during the clinical curriculum). During the first two years, students are taught basic sciences, and this part is referred to as the didactic portion of the curriculum. During the last two years, students are expected to participate in clinical rotations delivering care to a wide range of animals. In countries outside the United States, clinical participation is limited due to the lack of resources in the form of teaching hospitals or clinics. Additionally, in some countries, entry to

veterinary medical school happens immediately after completion of high school—unlike in the United States where college preparation is required for entrance. Finally, the veterinary profession in the United States educates students in treating every species while in other countries students specialize in one or two species from the beginning. In other words, specialization to one or two species does not exist during the four-years of the American veterinary medical curriculum.

As previously mentioned, curricula across the twenty-eight veterinary medical schools in the United States vary. The veterinary profession is evolving, and, more than ever, graduates are expected to possess certain competencies to treat the patient as well as the caretaker of the patient. The NAVMEC (2011) report presents an interesting summary of society's expectations of veterinarians as illustrated in the oath taken at graduation:

> "Being admitted to the profession of veterinary medicine, I solemnly swear to use my scientific knowledge and skills for the benefit of society though the protection of animal health and welfare, the prevention and relief of animal suffering, the conversation of animal resources, the promotion of public health, and the advancement of medical knowledge. I will practice my profession conscientiously, with dignity, and in keeping with the principles of veterinary medical ethics. I accept as a lifelong obligation the continual improvement of my professional knowledge and competence." (p. 12)

This oath implies an expected commitment from graduates to certain competencies veterinarians must have as they relate to technical (i.e., the capacity to deliver health care in a competent way) and non-technical (i.e., the capacity to deliver health care through communication and leadership) characteristics that are essential to success in any discipline (Lloyd, King, Mase, &

Harris, 2005). The veterinary medical school curriculum is an important and critical component of accreditation. NAVMEC recommends an engaging education, accreditation, and testing/licensure as the three legs of veterinary medical education (see Figure 2).

The curriculum at the MSU CVM is composed of three phases. Phase I focuses on normality, Phase II focuses on abnormality, and Phase III focuses on intervention and prevention. In other words, the curriculum is created from building blocks, from which knowledge and expertise are constructed as students' progress in the curriculum. Phase I and Phase II represent the didactic portion of the curriculum. Phase III reflects the clinical portion of the curriculum. By focusing on normality and abnormality, the coursework in Phase I and Phase II are designed to prepare veterinary students to move forward to the next steps of the

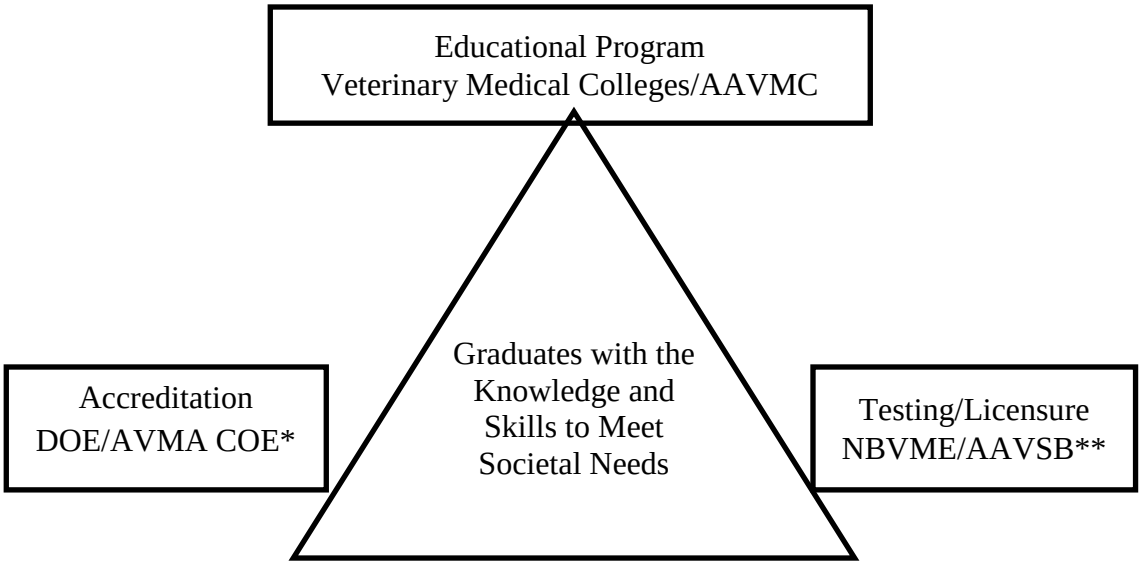


Figure 2. The Three Legs of Veterinary Medical Education
(adapted from the NAVMEC (2011) report)

* DOE/AVMA COE: U.S. Department of Education/American Veterinary Medical Association Council on Education

** NBVME/AAVSB: National Board of Veterinary Medical Examiners/American Association of Veterinary State Boards

curriculum, which trains students in the competent delivery of health care in a teaching and learning environment. Each of the three phases of the veterinary school curriculum are assigned grades. In the clinical curriculum, grading of student performance takes into account technical competencies as well as non-technical competencies. Although the clinical and didactic portions of the curriculum both have grades assigned, the clinical portion is more subjective because a variety of competencies are evaluated related to communications, interpersonal skills, navigating the clinic, and working with the healthcare team, to mention just a few. The very nature of the evaluation of students' clinical performance opens the door for potential biases. This delivery of care is expected to showcase competencies related to technical and non-technical skills, as outcomes are important to the profession and impact accreditation for institutions and licensing for graduates.

Professional Schools' Selection Characteristics

Institutions such as allopathic medicine, pharmacy, and dentistry schools value the importance of the personal attributes of practicing health care professionals; however, few programs have been able to implement selection methods that include non-cognitive variables (NCVs). The use of such criteria as interviews, file reviews, and reference letters remains an issue in admissions due to the need to make the selection of medical students effective, fair, and open (Oneil, Korsholm, Wallstedt, Eika, & Hartvigsen, 2009). Admission committee members at medical schools find it difficult to use NCVs because there is a belief that this method is not as defensible and valid as GPA and STS.

A study assessing pharmacy graduates' personal attributes once they were in practice reported that Doctor of Pharmacy (Pharm.D) program graduates believed their personal attributes were positive and essential to their success in practice (Doege & Assa-Eley, 2005). At the

Pharm.D institution at which their study was conducted, the curriculum was specifically enhanced to include courses focusing on patient-oriented aspects of pharmacy. Due to the interpersonal nature of the pharmacists' job, the pharmaceutical profession cannot leave to chance whether graduating pharmacists will acquire these necessary skills as they mature in their professional careers (Fjortoff & Zgarrick, 2001). The role non-cognitive characteristics play in the clinical and post-graduate environment is important, but curricula in most professional programs have little room for the inclusion of these skills (Lloyd & Walsh, 2002).

Selection Methods

There are a variety of admission practices among schools to select students for professional programs, and selection methods depend on the following factors (a) the institutional philosophy, goals, vision, mandates, or values and (b) admission committee membership. Some programs select students using only traditional criteria (e.g., grade point average and standardized tests). In contrast, other programs use a combination of traditional and non-traditional criteria, which is often referred to as a holistic admission process. In addition to evaluating test scores and GPAs, a holistic process may include an interview, a file review, a personal statement, a personality test, and/or a review of reference letters.

Many studies have identified the value of an undergraduate GPA as a powerful predictor of future academic success in VMSs; however, many of these findings are several decades old (e.g., Clapp & Reid, 1976; Confer & Lorez, 1990; Confer et al., 1999; Noeh, 1974). More recently, Turnwald, Sapfford, and Bohr (2001) reported that undergraduate GPAs and GREs were predictive of the first two years' performance for students in veterinary medical school. Kunnel (2005) found that student's undergraduate pre-pharmacy GPAs and their results from the Pharmacy College Admission Test were a moderate predictor of graduate pharmacy GPA.

However, no research has been conducted to identify characteristics predicting clinical performance at veterinary medical schools. There is growing evidence that performance during the clinical years and in practice is more related to non-traditional characteristics that applicants possess at admission, that is, which are not learned while enrolled in a program (Lievens et al., 2009). Recent research by Lievens et al. (2009) provided support for the inclusion of personality factors in selection as they "have a predictive value as to the success rate of admitted medical students. Considering personality of applicants can be quite helpful to medical school admissions programs" (p. 1516).

On the other hand, Schwitzer, Ancis, and Griffin (1988) found academic characteristics (e.g., standardized exams and GPA) had limited power in predicting academic and non-academic performance for college students. Moreover, these same authors suggested traditional cognitive variables were less useful in predicting the academic performance of African American males relative to African American females (Schwitzer, Ancis, & Griffin, 1988; see also Sedlacek 2004). Concerns over the use of traditional selection methods warrants an investigation to identify the best predictors of academic success for all groups and not just those traditionally enrolled in VMS.

Non-traditional Characteristics in Admission Selection

Non-traditional characteristics in admission selections may include numerous elements. The use of non-traditional characteristics in admission selection varies and can range from interviewing applicants and reviewing their files to evaluating reference letters. The most typical non-traditional selection methods are (a) a review of applicants' files to validate data and to evaluate written communication skills and other activities such as altruism, the applicant's knowledge of the profession, and his or her ability to work with others; (b) the personal

interview, which is used to evaluate verbal communication skills and the ability to problem-solve quickly; and (c) the reference letters submitted at the applicants' requests, which are often used to evaluate interpersonal skills and breadth of character.

Assessing verbal and written communication skills in admission selection is needed in a variety of health care professional programs because they require an evaluation of applicant's ability to perform critical tasks and behaviors, which include obtaining a medical history from the patient or, in the case of a veterinarian, the patient's owner, explaining the diagnosis and prognosis, giving therapeutic instructions, and counseling. A well-prepared health care provider needs good communication and interpersonal skills (Joint Commission, 2010).

The interview is another non-traditional selection characteristic. As part of the admission selection process, an interview can provide the admission committee with an opportunity to assess the applicant's communication skills and level of knowledge in the particular field, as well as their problem-solving abilities and interpersonal skills. These latter characteristics are inherently relational and process oriented (Duffy, Gordon, Whelan, Cole-Kelly, & Frankel, 2004). Furthermore, "interpersonal competencies involve the effect that communication has on another person such as relieving anxiety or establishing a trusting relationship" (Duffy et al., 2004, p. 497). Since interpersonal and communication competencies are viewed as important (Duffy et al., 2004), assessing these at entry and teaching them during coursework to future health care professionals is critical (Murray & Foster, 2000).

Reference letters are a third component used in the selection process at some professional programs to assess the characteristics of an applicant. Letters of reference allow professional schools admission committees to gain insights into relevant information that may otherwise be difficult to acquire from an applicant's grades or STSs (McCarthy & Goffin, 2001).

Examples of the relevant information could range from “applicant was dependable” to “applicant did not work well with others,” often with specific examples provided by the referee. Grades and standardized tests are not designed to provide the type of information that can be found in a reference letter.

Using interviews and letters of reference during the admission process has been called into question by administrators and admission professionals as these methods are often viewed as inherently subjective. It has been argued that if there are standardized questions and trained interviewers, then this method might be worth implementing as long as other components such as grade point average are also utilized. Reference letters have been under scrutiny because referees might not want to disclose negative information about an applicant to a medical school for fear of retribution. However, these two components are still part of the selection process at most professional schools in the United States. In veterinary medicine, the interview is a widely used selection tool (Lewis, van Walsum, Spafford, Edwards, & Turnwald, 2004). The veterinary profession has tried to address the issues related to the validity and reliability of interviews; however, some schools have decided to abandon the practice while others have continued with the practice and updated their interviewing methods to ensure a more reliable and valid assessment.

Admission Practices and Students’ Academic Success

In the health care field, communication and strong interpersonal attributes are catalysts for successful patient care and practice (Joint Commission, 2010). As a result, admission selection practices that include traditional and non-traditional characteristics have been designed and implemented at some VMSs. However, there are few studies examining their predictive power on students’ academic success, retention, clinical performance, or graduation (e.g., Astin,

1993; Tracy & Sedlacek, 1984). Tracy and Sedlacek (1984) defined non-cognitive variables as non-intellectual aspects of an applicant, such as self-concept, motivation, and personality. Veterinary schools using non-traditional characteristics in the admission selection of candidates have anecdotal evidence about their usefulness, citing diverse interests in selected students and support from their committees. There is some support for the incremental validity and practical usefulness of non-traditional components over the more traditional components (e.g., Cress et al., 2001; Willingham, 1985). However, critics of these methods argue they tend to be problematic for several reasons: (a) admission committees fail to apply a standardized validity to the various components, (b) the reliability of student reported data is questionable, and (c) the anticipated expense of additional faculty and admission committee members to assess applicants' files and interview performance is considerable (Willingham, 1985).

While an applicant's grade point average is often heavily relied upon to make admission selections, national trends in grade inflation have also increased so that the potential to discriminate among applicants is in question (Sedlacek, 2004). Moreover, because admission policies are created at the admission committee level, it is imperative to acknowledge that a one-size-fits-all policy might not work. As higher education institutions continue to evolve, as students continue to change, and as the needs of particular fields continue to transform, creating systematic ways to meet the needs of a changing society and demands of the evolving professions is necessary (Walsh, Osburn, & Schumacher, 2002).

Some institutions might be reluctant to abandon the false security of traditional admission components such as GPAs and STSs because it is cheaper, easier and less labor-intensive to use these characteristics than it is to evaluate applicants using narrative information (Sedlacek, 2004). Although test scores and grades are frequently cited as the best available predictors of

academic success in college, they rarely account for more than 10% of the variance in college success (Burton & Ramist, 2001). The combination of academic performance, standardized tests, and non-academic criteria may prove to be a better predictor of success than any of these criteria alone (Confer et al., 1999).

Of the 28 veterinary medical schools in the United States, only Colorado State University (CSU) reports the use of non-cognitive components in the selection of applicants. At CSU, the selection process integrates both traditional and non-traditional components to assess applicants (Kogan & McConnell, 2001). Each CSU admission committee member evaluates the applicant's files and makes a predictive judgment called a "subjective" admission. The basic premise of the subjective admission process at CSU VMS is that it is important to view applicants holistically and to select those who have optimal academic potential for completing the professional program and who have the greatest potential to contribute in a positive fashion to the veterinary profession (Kogan & McConnell, 2001).

The study of admission at CSU provides a foundation for an examination of non-traditional components in admission selection at a veterinary school as a legitimate part of the admission process; however, there are several issues not addressed in the CSU study. Most importantly, little was said about the influence of non-traditional admission components on students' academic performance during the didactic and clinical components of the curriculum.

In the selection process of undergraduate applicants, high school GPAs and STSs are normally used. For health care professions, admission selection is most typically conducted using undergraduate GPAs, science GPAs, and standardized tests such as the MCAT and/or the GRE. Pikes and Saupe (2002) found that high school GPA and STS consistently predicted college GPA. It is possible that health care professional schools have found some security in

using GPA as a major selection component as GPA was found to predict performance for undergraduate students. However, health care professional programs differ from undergraduate programs. To begin with, health care professional programs use different methods of instructions from most undergraduate programs—most importantly, theory application in the clinical environment. Therefore, it would be useful to assess different admission characteristics that might predict academic success in these different circumstances.

The literature generally lacks information about factors that influence veterinary school students' academic success. Over the past four decades, the literature is replete with studies that have assessed correlates of academic success. Yet there is a gap in the literature as it relates to characteristics that predict veterinary students' academic success in the didactic and clinical curriculum, and the current study sought to fill this gap in the literature.

In the current study, it was found that significant attention was given by the admission committees to cumulative GPA, science GPA, GRE, and non-traditional characteristics used to evaluate applicants for admission and to the predictive power these variables have on veterinary students' academic success during the didactic and clinical components of their degree programs. Figure 3 illustrates the design of the study and includes the information collected and assessed at the admission entry point by the MSU CVM Office of Admissions and Student Services, which allowed for a comparison of academic performance outcomes at completion of the veterinary school curriculum.

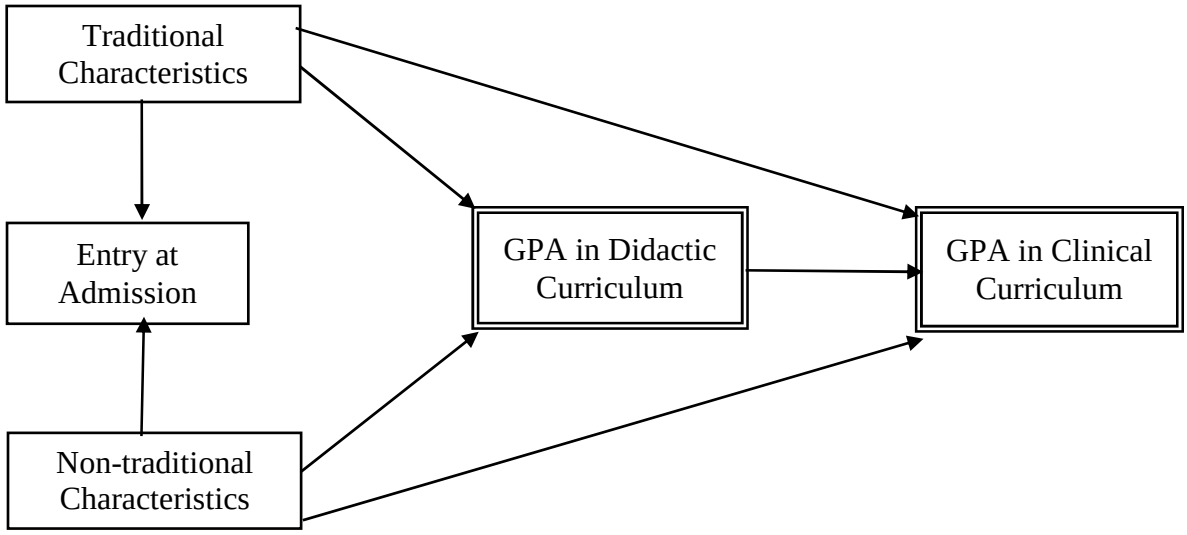


Figure 3. Design Model for this Study

Summary

The current status of American veterinary medical education is a product of many traditions and customs. Over the past twenty years, there have been several movements at the national level to refocus veterinary education towards a model that would address the challenges of a constantly evolving society that demands exceptional technical and non-technical skills from veterinarians to serve society's needs.

The literature on student development and factors that predict students' academic success at the graduate and undergraduate levels seems to call for strong non-traditional characteristics of admitted students. Astin's (1993) I-E-O model and Sedlacek's (2004) non-cognitive variables were shown to be appropriate frameworks to investigate and assess the influence predictor variables have on a student's veterinary school GPA at the completion of the didactic and clinical curricula. Indeed, both models have already been used to predict success at the undergraduate level; Astin's work has been used to study faculty and students in graduate school while Sedlacek's has been used to assess success of minority students at the undergraduate level.

Chapter Three discusses the methodology for this research study, including the study design, the institutional context, sample selection, instruments, data collection procedures, data analysis procedures, and other items pertaining to this research study.

CHAPTER 3

METHOD

Introduction

This research study analyzed how a set of variables influenced students' academic success as measured by grade point average (GPA) in veterinary school during the didactic and clinical portions of the curriculum. The students' GPA was chosen because of its acceptance as a measure of success by the veterinary profession. This chapter is divided into the following sections: the first part briefly restates the purposes and research questions of this study; the second part describes the study design (see Figure 3 above), setting, and operational definitions, and includes a sample selection procedure; and the chapter concludes with explanation of the instrumentation, data collection, and data analysis procedures, followed by a summary. Data collected during admission for seven cohorts of students admitted to MSU CVM from 2000 through 2006 were used in this study. These data are organized by what part of the veterinary medical school curriculum each cohort was in for the evaluation of variables that might predict students' academic success during didactic and clinical learning experience. The primary hypothesis was that the assessment of non-traditional characteristics during the veterinary medical school application process provides value beyond that provided by traditional characteristics with respect to students' academic success in the program. The analysis and interpretation of the findings related to this hypothesis may play an important role in gauging the utility of admission characteristics and in predicting students' academic success in veterinary medical programs.

Purpose of the Study

As described in Chapter One, the purpose of this study was to identify characteristics defined within an applicant pool of prospective students that predict admitted students' academic success in veterinary school. After more than four decades of research and supporting evidence in allopathic medicine, Adams and Frankle (2007) demonstrated that non-traditional student characteristics (i.e., communication and relationship building skills) influence the quality of academic performance, which, in turn, influence academic success during program enrollment. Since allopathic medicine has successfully used traditional and non-traditional characteristics to select future health care providers and as veterinary medicine programs are similar to program in allopathic medicine, it seems reasonable for veterinary medical schools to incorporate both sets of characteristics when assessing students for program selection to best predict academic success during the didactic and clinical years.

Research Questions

The following research questions were examined:

1. To what extent do traditional and non-traditional admission characteristics contribute to the prediction of cumulative grade point average (GPA) in the didactic portion of the veterinary medical school curriculum?
2. To what extent do traditional and non-traditional admission characteristics contribute to the prediction of cumulative grade point average in the clinical portion of the veterinary medical school curriculum?
3. To what extent does cumulative didactic GPA contribute to the prediction of cumulative clinical GPA in the veterinary medical school curriculum?

4. Do group differences exist between students placed/never placed on academic probation in terms of admission characteristics or academic performance?

Study Design

This non-experimental study was guided by Astin's (1993) I-E-O model and Sedlacek's (2004) model of non-cognitive or non-traditional variables. The former posits that input characteristics of applicants at the time of program admission can be predictive of program outcomes, while the later identifies demographic and traditional prospective student characteristics thought to best predict students' academic success. The use of traditional characteristics (e.g., GPA and GRE) as potential predictors of academic success are appropriate for study inclusion based on the research by Confer et al. (1999), who found that performance in the first year of veterinary school was positively correlated to GPA and STSs. In addition, Gore (2009) found that the use of non-traditional characteristics (i.e., file review and interview) in admission selection assisted in the identification of (a) students who entered with average GPA but with the potential to perform better than expected, (b) first-generation, academically underprepared students who did not perform well on standardized tests but who were engaged, resilient, confident, driven and mentally prepared to succeed, and (c) targeted student services that were helpful in supporting enrolled students.

Limitations

As with any research study, the current study must be interpreted in light of some limitations. The first limitation included the use of the summative interview score. In order to assess one of the variables, specifically the interview, the summative interview score was used rather than the individual scores for each category in the interview, which was due to the absence of individual scores in each category of the interview for each participant in the study. Future

research should include the scores for each interview category in the study design to provide detailed information relative to questions that actually identified goodness of fit between program and candidate. This information would be useful in the planning for the strong admission selection of candidates. The second limitation relates to the research being conducted at one institution (i.e., MSU CVM where the cohorts were admitted). Conducting a study at a single institution limits the researcher's ability to generalize since it would likely be difficult to apply the results to other veterinary schools across the United States. Furthermore, the study was conducted over a period of seven years, and may not be generalizable to future time periods because it was conducted at one institution rather than several institutions with diverse students and curriculum designs. Nevertheless, this research provides insight into characteristics that were predictive of academic performance in the didactic and clinical curriculum at MSU CVM during that time. In addition, while this study is not all encompassing, it may still provide guidance in selecting the best applicants for the profession. The findings from this study support the need for additional research at other institutions and the need for flawless, well-developed, and methodically applied selection criteria during the admission process. Clients, the profession, and administrators understand that an exceptional graduate is one who can serve society as demonstrated by his or her technical and non-technical competencies, which are directly associated with traditional and non-traditional characteristics. High science GPAs and standardized test scores are only a portion of the equation in the selection process. Moreover, the research findings suggest that, perhaps, there is a need to identify minimum cut-off scores for traditional characteristics upon admission based on subsequent academic probation status. This research provides insights into identifying veterinary medical students who are most likely to perform well in the didactic and clinical curricula.

Institutional Context

The study was conducted at MSU CVM, a large Midwest, land grant, research institution with three medical schools (osteopathic, allopathic, and veterinary). MSU CVM has a long tradition of educating veterinarians since 1910 (Ottinger, 2012) and has been ranked as one of the top veterinary schools in the United States. Although approximately 1,000 prospective students apply, limited enrollment allows the selection of 100 to 110 admitted veterinary medical students annually (Ottinger, 2012). The curriculum at MSU CVM has a total duration of four years, with the first five semesters (two-and-a-half years) dedicated to didactic learning experiences and the last four semesters (including one summer session) dedicated to clinical applications of learned knowledge.

MSU CVM is ranked as one of the top ten veterinary schools in the United States. During the time of the study, the school employed approximately 125 faculty members with responsibilities for teaching, research, and service. The school also houses a teaching hospital dedicated to service to small and large animals. During the time of the study, the average total student body enrolled in the Doctor of Veterinary Medicine ranged from approximately 400 to 420. Applicants to the program were not required to hold a baccalaureate degree to gain admission to the program; as a result, a vast majority (between 60% to 70%) of enrolled students in the program are between 18 and 22 years of age. Applicants to the program are selected based on the criteria outlined on Appendix A.

Operational Definitions

Operational definitions are given below to ensure clarity:

1. Academic Success: Positive college grade point average at or above a passing score.

2. Average GPA: The minimal passing grade allowing student progression in the veterinary program of study. At this institution, the minimum acceptable GPA for progression was a 2.00 on a 4.00 scale.

3. Interview Score: A sum of numbers assigned by admission committee personnel based on applicants' responses to questions posed during an interview. The interview process assessed activities related to (a) community involvement, (b) knowledge of the profession, (c) problem-solving, (d) motivation and enthusiasm, and (e) leadership. Details of the scoring guide appear in Appendix D.

Data Collection, Preparation, Sample Selection and Description

The population of interest in this research study consisted of seven cohorts of veterinary program graduates who were admitted to MSU CVM from 2000 to 2006 and who completed their degrees from 2004 to 2011. No inducements were provided for participation. The researcher submitted a letter requesting data to the Office of the Dean at MSU CVM (Appendix C). Permission for access to these data was granted by the Office of the Dean via letter to the researcher. The sample was acquired after consultation with the veterinary medical school Office of the Dean personnel responsible for these data. Following permission for access to data, appropriate requests were submitted for Institutional Review Board (IRB) approval to conduct this research. The IRB Office approved the research and, immediately after approval, the data were provided to the researcher by MSU CVM. To ensure the privacy of graduates from the veterinary medical school, no identifying information was included as stipulated by the Family Educational Rights and Privacy Act

During the 2000 to 2006 admission cycles, students at MSU CVM were selected on the basis of traditional and non-traditional characteristics. The yearly pool of applicants from 2000

through 2006 ranged from 883 in 2005 to 1253 in 2000. The data on applicants and admitted students annually from 2000 to 2006 as reported in the MSU CVM Application and Admission Data can be viewed in Table 1.

Table 1
MSU CVM Application and Admission Data from 2000 to 2006

Year of Application	2000	2001	2002	2003	2004	2005	2006	Total
Number of Applicants	1253	1108	974	1010	1014	883	1008	7250
Number Admitted	105	104	104	108	107	108	108	744
Percentage Admitted	8.3%	9.3%	10.6%	10.6%	10.0%	12.2%	10.7%	10.3%

During the 2000 – 2006 admission cycle, staff in the MSU CVM Admissions Office evaluated a variety of traditional and non-traditional characteristics for applicants to the veterinary medical school (see Table 2 for a complete list of these characteristics).

Table 2.
Traditional and Non-Traditional Characteristics Collected in Veterinary Medical Applications

	Characteristics	Description/Abbreviation
Traditional	Cumulative Grade Point Average	Pre CUMUL GPA
	Last 45 Credits Grade Point Average	Last 45 GPA
	Science Grade Point Average	SCI GPA
	Graduate Record Examination	GRE Quant
	Verbal and Quantitative	GRE Verbal
	Total Number Credits	Total CR
Non-Traditional	Age	Age in Years
	Sex	Female, Male
	Ethnicity	White, Non-White
	Interview	Interview (from 15 to 35)
	Parent Veterinarian	Yes, No
	Prior Degree	None, Non-Science, Science
	Residency	Michigan, Non-Michigan

Instrumentation

The researcher evaluated traditional and non-traditional characteristics collected from students at admission. The traditional characteristics evaluated were (a) science GPA, (b) GRE

Verbal score, and (c) GRE Quantitative score. Science GPA had a maximum score of 4.00, and each component of the GRE standardized test had a maximum score of 800 during the period of this study and prior to subsequent changes to scoring the GRE examination.

The non-traditional characteristics evaluated were interview scores with ratings that assessed students' (a) self-reported community service, (b) self-reported leadership activities, and (c) knowledge of the profession. Each component of the interview was measured on a 7-point scale, using a rubric and scoring sheet developed by members of the committee on student admission, and yielding a total interview score that ranged from a minimum of 15 to a maximum of 35. An example of the interview questions and scoring guide, which was used to score applicants' interview responses appears in Appendix D. Prior to participating in the interview process and scoring interview responses, all raters were trained on the appropriate use of the rubric and scoring sheet. During each annual interview period, approximately 20 to 26 faculty members volunteered to serve as raters. Participants in the interview process were provided with training at least a month prior to interviews.

The interview training involved a full-day workshop typically held in February of each year (the interviews were held late February through early March) and given by a nationally recognized professional in psychology and interviewer training for medical schools, using research by Edwards, Johnson, and Molidor (1990) as a foundation. During the workshop, questions for the interviews were developed and submitted later for approval by the Committee on Student Admissions. Faculty members also received a list of illegal and inappropriate interview questions; in addition, protocols for how to start and end the interviews were discussed, with particular emphasis paid to interviews at which the prospective students demonstrate their knowledge of other cultures. Finally, an interviewer's guide was developed

and shared with interviewers for their reference (Appendix D). This guide was developed in collaboration with the trainer and with input from faculty and the admission team.

Interview questions developed by faculty interviewers and the admission committee members were guided initially by research by Tracey and Sedlacek (1984) and Lewis and Klausner (2000) and were further refined taking into consideration updated work by Sedlacek (2004), which also informed the development of the guide. Although the interview questions developed were not tested for psychometric measures, admission committee members were confident that, by providing structured questions—and by providing a rubric for interviewers—the interviews would be fair and valid. On multiple occasions, it was confirmed that interviewers were consistent with their ratings and inter-rater reliability existed; however, there is always the possibility that interviewers did not follow the assigned script and rubric in every case. On the other hand, there was a certain level of confidence that interviewers would follow the assigned structure since the interviews were conducted by two faculty interviewers for each applicant. It is certainly possible, however, that, although interviewers were trained and provided with the questions (which remained the same from year to year), sample answers, and a rubric, and attended a follow-up meeting after the interviews, some interviewers may have decided to deviate from the given structure, which may have led to inconsistencies in the interviews.

The admission selection process from the years 2000 through 2006 used traditional selection components (Science GPA and Standardized Test scores) and non-traditional components (the interview) to select applicants to start the veterinary medical school professional curriculum each fall semester. Prior to the interview, a calculation of scholastic indicators was conducted to verify that applicants had the academic preparation to move forward

into the interview process. The Scholastic Indicator Score was composed of (a) cumulative GPA, (b) science GPA, and (c) GRE Verbal and Quantitative scores. The traditional components were assigned differential weights based on their expected contribution to academic success and were summed to create the total Scholastic Indicator score. All applicants for each year were then rank ordered in descending order of the total score. Using that ranking, the top 200 applicants were selected to participate in the interview (usually lasting 30 to 40 minutes), which was conducted on site. Rating scores from the interview were then included in a revised Scholastic Indicator equation and students were again rank ordered in descending order using the combination of traditional and non-traditional components to select a final class of 100 to 110 students annually.

The scholarship of enrollment and admission selection in veterinary medicine has focused on the predictive power of the science grade point average (SCI GPA) and the standardized test results (STRs), and on academic performance during the preclinical curriculum at veterinary medical schools (Turnwald et al., 2001). The vast majority of published studies examining the influence of academic (cognitive or traditional) and personal (non-cognitive or non-traditional) attributes used in selection decisions on graduate academic performance in veterinary medicine have been conducted in North America (e.g., Craven, 2004). To this author's knowledge, this research study is the first to study the contribution of traditional (science GPA, STRs), and non-traditional characteristics (age, gender, residency, and interview score) on students' academic performance during preclinical and clinical curricula at a veterinary medical school. Table 3 outlines a list of the variables included in the admission dataset.

Table 3.
List of Variables Included in the Admission Dataset

Variable	Description
Unique Identifier	An unique identification number to match cases across datasets
Admission Year	Year in which each student was accepted to veterinary school
Age	Student age at admission (in years)
Ethnicity/Race	Students' ethnic/race classification
Cumulative GPA	Cumulative Grade Point Average at admission
Last 45 Credits GPA	Grade Point Average for last 45 completed credits at admission
Science GPA	Science Grade Point Average at admission
Graduation Year	Year in which each student graduated from veterinary school
GRE Quantitative	GRE Quantitative test score
GRE Verbal	GRE Verbal test score
GRE Total	Sum of GRE Verbal and Quantitative scores
Interview Score	Total Interview score at admission (from 15 to 35)
Biological Sciences MCAT	Biological Sciences MCAT score
Physical Sciences MCAT	Physical Sciences MCAT score
Verbal Reasoning MCAT	Verbal Reasoning MCAT score
Parent Veterinarian	Parent veterinarian (Yes or No)
Pre-College status	Pre-College school location (Michigan, Non-Michigan)
Prior Degree	Prior Degree status (None, Non-science, Science, Other)
Residency status	Resident status (Michigan, Non-Michigan, International)
Scholastic Indicator	Scholastic Indicator (weighted by cumulative and science GPA and GRE total)
Sex	Student sex (Female or Male)
Total Credits	Total Number of Completed Credits at admission

Data Collection Procedures

Data for this research were collected after obtaining permission to access student information from the school registrar. The request for data access specifically outlined academic and admission variables of interest for veterinary medical school graduates who were admitted to the program between 2000 through 2006.

Data included information from interviews of seven student cohorts at the time of admission, from the students' scores at the time of completion of the didactic curriculum component, and from the students' scores at the time of completion of the clinical curriculum component. Although individual student data were obtained within each cohort, the lack of

identifying information connecting individual students to student records meant that it was not possible to clarify or correct incomplete or confusing data.

Data Analysis Procedures

For this study, a minimum required sample size of 575 was needed to avoid a Type I error rate above a significance criterion of .05 with power set at a conventional level of .80. This population effect size was estimated based on other non-veterinary studies related to the strength of admission variables to predict academic performance.

All statistical analyses were computed using SPSS Version 20.0. Prior to performing analyses related to the study questions, individual cases in the obtained data were evaluated for accuracy. Cases were removed for two reasons: (a) data on predictor or outcome variables reflected values that were outliers, and (b) data on predictors or outcome variables were missing.

Inspection of frequencies in the reduced merged data revealed that the majority of students were White (89.3%) Female (83.7%) Michigan residents (74.7%) between the ages of 18 to 22 years (61.4%) who had entered with a prior degree in science (61.4%). For the purpose of this research study, data on ethnicity was collapsed and classified as White and non-White due to the small number of minority participants. Non-White participants were inclusive of Hispanics, African Americans, Asians, Native Americans, and Multiracial groups. The demographic characteristics of the reduced merged data are provided on Table 4.

Table 4.
Demographic Characteristics of the Reduced Merged Data (N = 676)

Characteristic	n	Percent
Age Groups		
18 – 22	415	61.4%
23 – 28	218	32.2%
29 – 56	43	6.4%
Ethnicity/Race		
White	604	89.3%
Non-White	72	10.7%
Prior Degree[a]		
None	140	21.1%
Non-Science	52	7.8%
Science	475	71.7%
Resident Status		
Michigan	505	74.7%
Non-Michigan	171	25.3%
Sex		
Female	566	83.7%
Male	111	16.3%

Note. [a]. = 12 participants were classified as "Other", thus the total sample size is 667. Totals of percentages are not 100 for every characteristic due to rounding.

The questions in the study were evaluated using inferential analyses to examine differences in dependent variables as a function of independent variables and to examine relationships between predictors and outcome variables using linear regression. Frequencies and descriptive statistics for all sample demographics (i.e., cumulative grade point average, science grade point average, scores from the Graduate Record Examination components), and interview scores (see Appendix D for interview questions and scoring guide) were computed. The students' results at the completion of the didactic learning experience and clinical application components of the curriculum were selected as the best measures to assess academic success. An alpha level ($p < .05$) was chosen to determine statistical significance of all results.

The statistical analyses selected for the study are similar to those used in other academic success and retention studies. Previous studies have examined the predictive validity of multiple independent variables of academic success and persistence (Boyer & Sedlacek, 1989, Carmichael, Burke, Hunter, Labat, & Sevenair, 1986; House, 1994; Sedlacek, 2004; Tracey & Sedlacek, 1984). Frequencies and percentages were generated to describe the sample demographics of importance such as gender, age, and prior degree.

The researcher performed regression analysis to determine the contribution of the selected non-cognitive variables (community service, leadership, and knowledge of the profession) and traditional variables (science GPA and STS) to the prediction of students' academic performance. The Statistical Package for Social Sciences (SPSS Version 20.0) was used to conduct multiple regression concerning scores at two junctures in the curriculum using the didactic and clinical GPAs as the outcome variables and the interview score assessed at admission and the traditional characteristics at entry (science GPA, STS, and interview scores) as the predictor variables.

Collected data were first categorized by the seven cohorts as defined by the date of admission to the veterinary medical program. Next, data were categorized by the three input categories, Demographic, Traditional, and Non-traditional Characteristics. The category of Demographic Characteristics included information such as gender, ethnic background, age, and undergraduate degree. The category of Traditional Characteristics aligned with Astin's (1993) work, which predominately examined cognitive assets such as undergraduate science grade point average, cumulative grade point average, and Graduate Record Examination scores. The final category, Non-traditional Characteristics, aligned with Sedlacek's (2004) work in defining social

characteristics and included information assessed during the interview such as leadership, community service, and knowledge of the veterinary profession.

Descriptive statistics and regression analysis have been used previously as statistical techniques to explore and model predictive relationships between two or more variables (Boyer & Sedlacek, 1989; Carmichael et. al, 1986; Pallant, 2001; Tracey & Sedlacek, 1984). As this research examined the contribution of students' traditional and non-traditional characteristics at the time of program admission to their academic performance during the program, linear regression was the appropriate analysis for testing and interpretation.

Summary

In this chapter, the theoretical frameworks, the data analysis framework, the population and samples of interest, the data collection procedures, and the source of the data were outlined. Data for admitted students in the years 2000 through 2006 at MSU CVM were collected and analyzed. The data were deemed to be reliable as the institution provided them directly to the researcher for this research study.

Results of the data analyses are provided in Chapter Four, and recommendations for further study as well as policy implications for admission professionals at veterinary schools are found in Chapter Five.

CHAPTER 4

RESEARCH FINDINGS

The information in this chapter is presented in five sections. The first section includes information about data preparation, screening, and merging. The second section includes an interpretation of the findings from descriptive statistics and analyses testing assumptions of normality in the final dataset. The third section contains the interpretation of the analyses performed to examine sample equivalence at admission. The fourth section includes the results of regression analyses performed to examine the first three research hypotheses. The fifth section includes an interpretation of results examining differences at admission and academic performance as a function of academic probation. The research questions were

1. To what extent do traditional and non-traditional admission characteristics contribute to the prediction of cumulative grade point average (GPA) in the didactic portion of the veterinary medical school curriculum?
2. To what extent do traditional and non-traditional admission characteristics contribute to the prediction of cumulative grade point average in the clinical portion of the veterinary medical school curriculum?
3. To what extent does cumulative didactic GPA contribute to the prediction of cumulative clinical GPA in the veterinary medical school curriculum?
4. Do group differences exist between students placed/never placed on academic probation in terms of admission characteristics or academic performance?

The results concerning the characteristics that predict didactic and clinical performance at MSU CVM are provided in this chapter. Additionally, the extent to which traditional and non-

traditional admission characteristics contribute to the prediction of academic performance and explain differences in academic probation status are given.

Data Screening and Merging of Cases into a Single Dataset

The Registrar at MSU CVM provided two datasets for this research. The Admission dataset contained 726 cases with information related to admission characteristics of students who were admitted into MSU CVM (see Table 3 in the previous chapter for a complete list of variables). The Academic Performance dataset contained 694 cases with information about the academic performance by semester of students who matriculated and graduated from the veterinary medical school (see Table 5 for a complete list of variables).

Table 5.
List of Variables Included in the Academic Performance Dataset

Variable	Description
Unique Identifier	An unique identification number to match cases across datasets
Beginning Term/Year	Term and year in which each student matriculated
Cumulative GPA	Cumulative grade point average for all completed semesters
Term GPA	Grade point average for each semester of coursework
Didactic GPA	Cumulative grade point average for the first five semesters [Coursework = 81 lecture hours, 47 laboratory hours]
Clinical GPA	Cumulative grade point average for the last four semesters [Clerkships = 33 required hours, 27 elective hours]
Academic Probation	Academic Probation in the program (Yes or No)
Semester Status	Semester status (Extended for academic probation, leave of absence, personal reasons; Transfer)

To test the research hypotheses, I merged the variables across the two datasets into a single database using the shared unique identification numbers. Prior to merging the variables, three examinations of the data were performed to identify cases that should be removed due to issues with the dataset. The three examinations of data were necessary as the datasets were provided by the Admissions Office and the Registrar's Office three different times. To ensure data integrity, careful review of data had to be performed each time. First, frequencies and

descriptive statistics were reviewed for each variable in each dataset. This examination accomplished two goals: (a) to identify situations in which observed values for variables were coded incorrectly and (b) to identify students whose academic progress in the veterinary school curriculum was characterized by a leave of absence, an extended curriculum due to personal reasons, or entrance as a transfer student. Second, the data were reviewed to determine if information needed to test the research hypotheses was missing. Third, the unique identification numbers were compared across datasets to ensure that a match was present. Based on the results of these examinations, thirty-five cases were removed from one or both datasets prior to merging cases into a single dataset (see Table 6 for more detailed information).

Table 6.
Frequency of Cases Deleted as a Function of Removal Reason

Removal Reason	Frequency
Out-of-Range values in the Admission data	1
Out-of-Range values in the Academic Performance data	1
Student cases characterized by leave of absence, extended curriculum for personal reasons, or entrance as transfer student	10
Cases with unique identification numbers without a match in the other dataset	23
Total Number of Cases Removed	35

As noted in Table 1 (i.e., MSU CVM Application and Admission data from 2000 to 2006), 744 students were accepted into the school in the study period. To ensure the validity and representativeness of the data obtained for this research, the distribution of students admitted each year in the Admission and Academic Performance datasets and in the final merged database were compared to the frequencies in Table 7. Although 35 cases were removed prior to merging into a single dataset, the final sample size of 683 still represents 91.8% of the original 744 cases. The percentage of cases by year relative to the original frequency of cases in the MSU CVM Application and Admission data ranged from a low of 84.6% in 2001 to a high of 97.2% in 2003.

Table 7.
Distribution of Student Representation by Admission Year as a Function of Dataset

Year	University Application and Admission Data	Admission Data	Academic Performance Data	Merged Data[a]
2000	105	104	99	99 (94.3%)
2001	104	94	93	88 (84.6%)
2002	104	101	100	98 (94.2%)
2003	108	107	104	105 (97.2%)
2004	107	106	96	101 (94.4%)
2005	108	107	98	95 (87.9%)
2006	108	107	104	97 (89.8%)
Total	744	726	694	683 (91.8%)

Note. [a]. Values in the merged data column represent frequencies followed by the percentage of available cases in the merged dataset relative to the percentage of cases reported in the University Application and Admission data. For example, in the merged data column, the 99 cases available in 2000 represent 94.3% of the 105 cases in the University Application and Admission data reported in 2000.

To examine the degree of sample equivalence across the seven selected cohorts in the final dataset, a series of chi-square analyses and one-way analyses of variance were performed. Chi-square analyses were performed to examine the proportional distributions of ethnicity, prior degree, residency, and sex by admission year. No patterns of association were noted for ethnicity or residency. A significant association was noted for sex by admission year, χ^2 (6, N = 283) = 14.17, $p < .05$, $\phi_C = .14$. Specifically, fewer males were admitted in the 2001 cohort (4.5%) than in any other cohort year (range 14.1% to 22.8%). Another significant association was noted for prior degree and cohort year, χ^2 (12, N = 669) = 28.28, $p < .01$, $\phi_C = .15$. Specifically, more students were admitted with science degrees in 2006 (85.4%) than in all preceding years (range 62.9% to 74.0%).

One-way analyses of variance were performed to examine if admission characteristics and/or academic performance differed as a function of cohort year. No differences emerged for GRE Verbal, GRE Quantitative, Age, Didactic GPA, or Clinical GPA by cohort year. Two main

effects were noted by cohort year, however. The first main effect was noted for science GPA and cohort year, F (6, 682) = 9.97, $p < .01$, $\eta^2 = .08$. Interpretation of a Dunnett T3 post-hoc analysis indicated that students who were admitted in 2005 had significantly lower science GPA than did students admitted in 2003, 2004, or 2006. Further, students admitted in 2000, 2001, and 2002 had significantly higher science GPA than students admitted in later years, with the exception of students admitted in 2004 (see Figure 4 for depiction of the main effect).

The second main effect was noted for interview score and cohort year, F (6, 682) = 32.38, $p < .01$, $\eta^2 = .22$ (see Figure 5 for depiction of the main effect). Interpretation of a Dunnett T3 post-hoc analysis indicated that students who were admitted in 2000 and 2001 had significantly lower science interview scores than did students admitted in later years.

Descriptive Statistics and Frequencies for the Merged Dataset

Prior to performing analyses to test the research hypotheses, assumptions of normality were assessed in interval and ratio variables by examining means, standard deviations, and skew values and kurtosis (see Table 8). Normal distributions were exhibited across variables with the exception of Age, which had a moderate positive skew value of 3.33. To achieve normality, seven cases with outlier values were removed and a square root transformation was performed. Following these changes, the skew value for Age was 1.95 and the total number of cases in the merged data was 676. Using the reduced merged data with 676 cases, the means, standard deviations, skew, minimum, and maximum values were recalculated for interval and ratio variables (see Table 9).

Table 8.

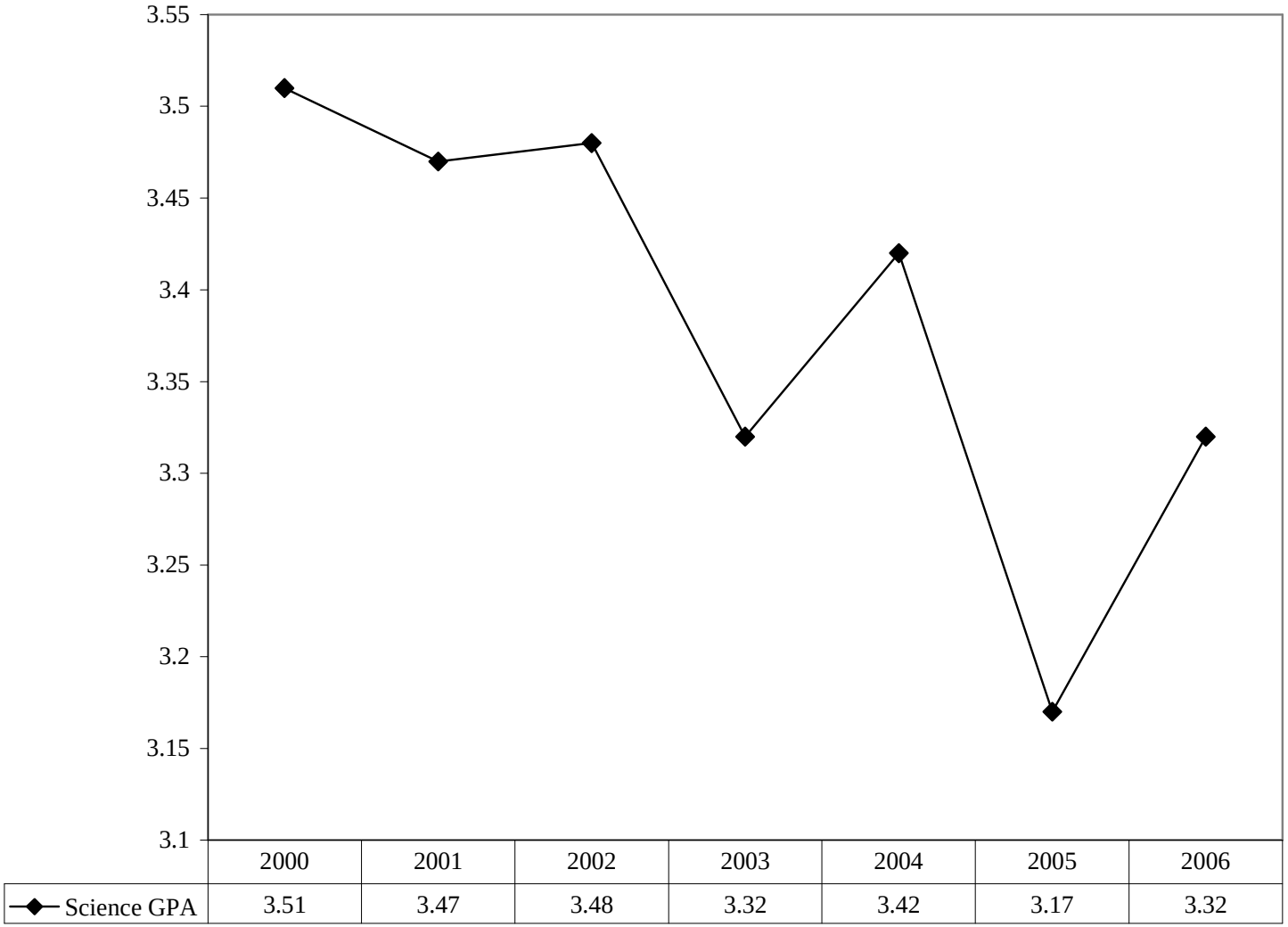
Descriptive Statistics for Interval and Ratio Variables in the Merged Data (N = 683)

Variables	Mean	Standard Deviation	Skew	Minimum	Maximum
Age (Square Root Transform)	23.00	4.10	3.33	18.00	56.00
GRE Verbal	505.93	89.42	.15	80.00	800.00
GRE Quantitative	642.78	78.82	-.46	50.00	800.00
Science GPA	3.39	.39	-.45	2.00	4.00
Interview	26.98	3.63	-.23	15.02	35.00
Didactic GPA	3.15	.46	-.02	2.10	4.00
Clinical GPA	3.46	.23	-.93	2.38	3.92

Table 9.

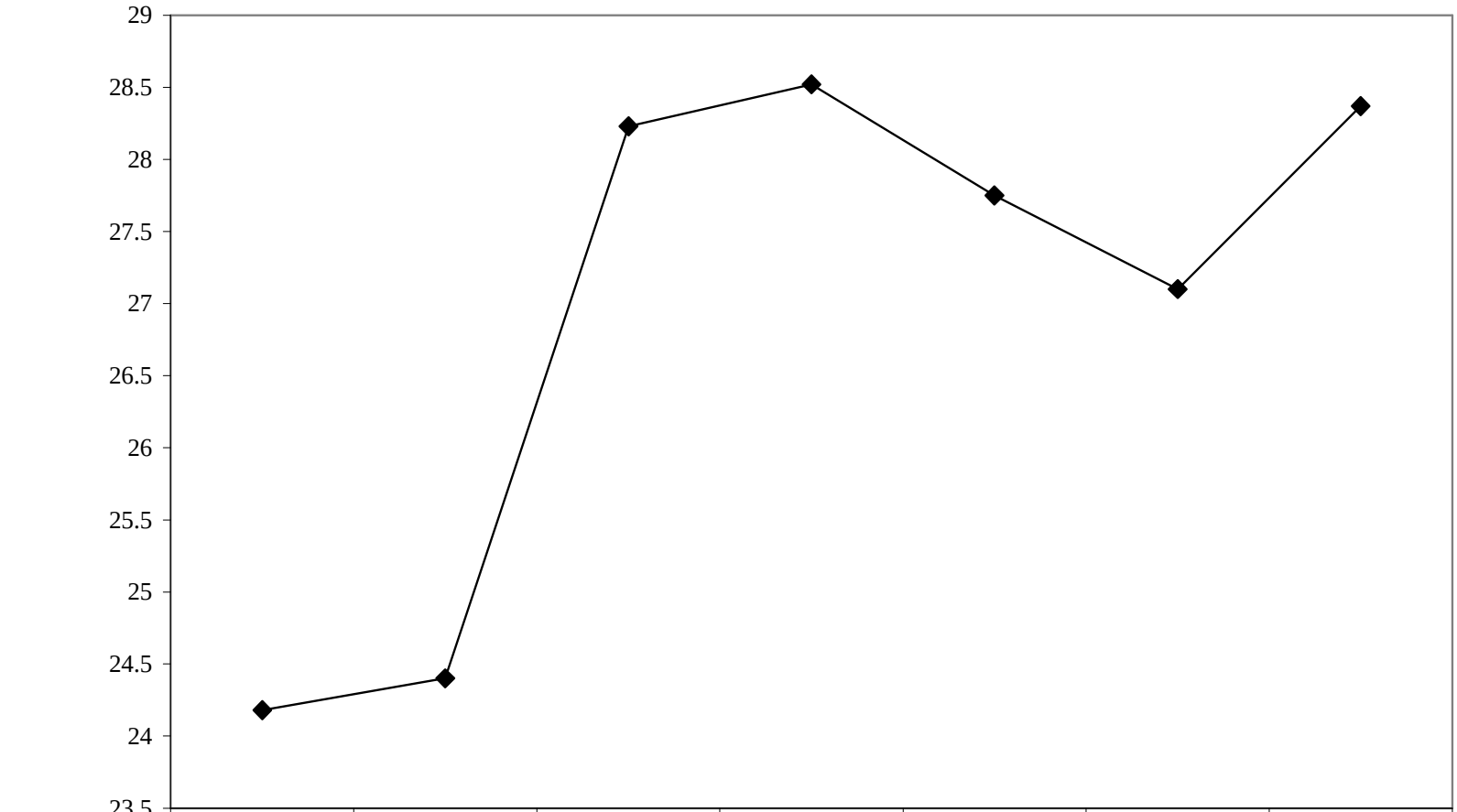
Descriptive Statistics for Interval and Ratio Variables in the Final Merged Data (N = 676)

Variables	Mean	Standard Deviation	Skew	Minimum	Maximum
Age (Square Root Transform)	4.76	.32	1.95	4.24	56.00
GRE Verbal	505.65	89.61	.16	280.00	800.00
GRE Quantitative	643.12	78.97	-.47	350.00	800.00
Science GPA	3.39	.39	-.47	2.00	4.00
Interview	26.96	3.62	-.24	15.02	35.00
Didactic GPA	3.15	.46	-.01	2.10	4.00
Clinical GPA	3.47	.23	-.90	2.38	3.92



	2000	2001	2002	2003	2004	2005	2006
Science GPA	3.51	3.47	3.48	3.32	3.42	3.17	3.32

Figure 4 . Science GPA as a Function of Cohort Year



	2000	2001	2002	2003	2004	2005	2006
Interview	24.18	24.4	28.23	28.52	27.75	27.1	28.37

Figure 5. Interview Score as a Function of Cohort Year

Sample Equivalence Tests for Admission Characteristics and Academic Performance

To ensure appropriate interpretation of the results related to the research questions, sample equivalence tests were performed. Ideally, values on admission characteristics should not differ by pre-existing group classifications. If group differences are found to exist, then subsequent findings must be interpreted cautiously. In this study, sample equivalence of interval and ratio admission characteristics were evaluated as a function of students' ethnicity, prior degree, residency, and sex. Independent t-tests were performed for sample equivalence tests on ethnicity, residency, and sex. One-way analyses of variance were performed for sample equivalence tests on prior degree. Complete information related to these examinations is available in Tables 10, 11, 12, and 13.

Interpretation of the results indicated that one or more significant differences in admission characteristics existed across all group comparisons. Specifically, White students had significantly higher GRE Verbal scores, GRE Quantitative scores, and cumulative science grade point averages than did non-White students (see Table 10). Four main effects were found as a function of students' prior degree (see Table 11). In terms of traditional admission characteristics, two differences were noted. First, students who entered without any prior degree and students with a prior science degree both had significantly lower GRE verbal scores than students with a non-science degree. Second, students who entered with a non-science degree or a science degree had significantly lower cumulative science grade point averages than students who entered without any prior degree. Further, students who entered without a prior degree had significantly lower interview scores than students who had a science or non-science degree. Finally, students who entered without a prior degree were significantly younger than students with a science degree who were significantly younger than students with a non-science degree.

Three significant differences were noted as a function of students' residency status. Students who were non-Michigan residents had significantly higher GRE Quantitative score, interview scores, and were significantly older than Michigan residents (see Table 12). Two significant differences were noted as a function of students' sex (see Table 13). Specifically, male students had significantly higher GRE Quantitative scores and interview scores than did female students.

Table 10.
Sample Equivalence Tests on Admission Characteristics as a Function of Ethnicity (N = 676)

	White n = 604		Non-White n = 72			
Characteristic	*Mean*	*SD*	*Mean*	*SD*	df	*t*
Age	22.76	3.34	22.76	2.98	674	- .01
GRE Verbal	509.59	87.15	472.64	103.00	83.56[a]	2.92**
GRE Quantitative	645.58	76.80	622.50	93.29	674	2.35*
Interview	26.91	3.64	27.42	3.43	674	-1.13
Science GPA	3.40	.38	3.26	.40	674	3.06**

Note. [a]. A pooled t-test was used because the assumption of homogeneity was violated.
* $p < .05$. ** $p < .01$.

Table 11.
Means, Standard Deviations, and One-Way Analyses of Variance on Admission Characteristics as a Function of Prior Degree (N = 664)

	None n = 140		Non-Science n = 52		Science n = 472		F	
Characteristic	*Mean*	*SD*	*Mean*	*SD*	*Mean*	*SD*	(2, 663)	η^2
Age	20.91_a	2.12	25.71_c	4.79	22.92_b	2.95	52.86**	.14
GRE Verbal	487.50_a	80.74	548.85_b	95.29	506.82_a	89.69	9.21**	.03
GRE Quantitative	638.71	76.60	665.96	80.13	642.90	79.29	2.27	.00
Interview	26.06_a	3.73	28.06_b	3.82	27.15_b	3.49	7.64*	.02
Science GPA	3.52_b	.37	3.34_a	.42	3.35_a	.38	11.08**	.03

Note. * = $p < .01$. ** = $p < .001$. Means with different subscripts differ significantly from one another.

Table 12.
Sample Equivalence Tests on Admission Characteristics as a Function of Residency (N = 676)

	Michigan n = 505		Non-Michigan n = 171			
Characteristic	*Mean*	*SD*	*Mean*	*SD*	df	*t*
Age	22.51	3.17	23.48	3.57	267.03[a]	- 3.33**
GRE Verbal	503.09	87.90	513.22	94.35	674	-1.28
GRE Quantitative	639.66	77.48	653.33	82.59	674	-1.96*
Interview	26.68	3.61	27.81	3.49	674	-3.56**
Science GPA	3.38	.39	3.40	.39	674	-0.52

Note. [a]. A pooled t-test was used because the assumption of homogeneity was violated.
* $p < .05$. ** $p < .01$.

Table 13.
Sample Equivalence Tests on Admission Characteristics as a Function of Sex (N = 676)

	Female n = 566		Male n = 110			
Characteristic	*Mean*	*SD*	*Mean*	*SD*	df	*t*
Age	22.74	3.36	22.87	3.02	674	- 0.40
GRE Verbal	508.43	89.74	491.36	87.95	674	1.83
GRE Quantitative	639.98	78.92	659.27	77.56	674	-2.35*
Interview	26.84	3.63	27.58	3.49	674	-1.96*
Science GPA	3.40	.38	3.34	.42	674	1.45

Note. * $p < .05$.

To examine sample equivalence across nominal admission characteristics, a series of chi-square analyses were performed. Proportional distributions were compared across student ethnicity, prior degree, residency, and sex. No patterns of association were revealed across proportional distributions of student ethnicity, prior degree, or sex. In contrast, associations between student residency and ethnicity, student residency and prior degree, and student residency and sex were significant. Specifically, Michigan residents were significantly more likely to be White (94.9%) than non-White (5.1%). When students were non-White, they were proportionally more likely to be non-Michigan residents (26.9%), χ^2 (1, N = 676) = 63.51, $p < .001$, $\phi_C = .31$. In addition, Michigan residents were significantly more likely to be female

(85.3%) than male (14.7%). When students were male, they were proportionally more likely to be non-Michigan residents (21.1%), χ^2 (1, N = 676) = 3.84, p < .05, ϕ_C = .08. Finally, while Michigan and non-Michigan residents were both more likely to have a science degree (68.4% versus 78.8%, respectively), there was a stronger tendency for Michigan students to have no degree (25.7%) as compared to non-Michigan residents (7.6%). Moreover, while very few Michigan residents had a non-science degree (5.9%), non-Michigan residents were substantially more likely to have a non-science degree (13.5%), χ^2 (2, N = 664) = 30.97, p < .001, ϕ_C = .22.

To examine sample equivalences across academic performance, several analyses were performed. Ideally, values on academic performance should not differ by pre-existing group classifications. If group differences are found to exist, then results from the regression analyses examining the research questions may reflect the contribution of confounding variables. In this study, sample equivalence of academic performance (i.e., measured by cumulative didactic GPA and cumulative clinical GPA) was evaluated as a function of students' ethnicity, prior degree, residency, and sex. Independent t-tests were performed for sample equivalence tests on ethnicity, residency, and sex. One-way analyses of variance were performed for sample equivalence tests on prior degree.

No differences in academic performance were noted as a function of students' residency, sex, or prior degree. In contrast, significant differences were noted in both cumulative didactic and cumulative clinical GPA as a function of ethnicity. Specifically, White students had statistically significantly higher cumulative didactic GPAs (M = 3.17, SD = .46) as compared to non-White students (M = 3.05, SD = .44), t (674) = 2.12, p < .05, η^2 = .006. Furthermore, White

students also had significantly higher cumulative clinical GPAs (M = 3.48, SD = .23) as compared to non-White students (M = 3.37, SD = .24), t (674) = 3.83, $p < .001$, $\eta^2 = .021$.

The following sections report the results in relationship to the specific research questions. Each question will be restated with its corresponding findings. Additionally, each test conducted for the analyses will be stated and interpretation of findings provided.

Research Question 1

To what extent do traditional and non-traditional admission characteristics contribute to the prediction of cumulative grade point average (GPA) in the didactic portion of the veterinary medical school curriculum?

To determine if traditional and/or non-traditional characteristics contributed to didactic GPA, a linear multiple regression analysis was performed. Variables tested as traditional predictors included GRE Quantitative and Verbal scores and cumulative science GPA. Variables included as non-traditional predictors included students' age (transformed), ethnicity (dummy coded as White or non-White), interview score, prior degree (dummy coded into two variables—prior degree versus no degree, and science degree versus non-science or no degree), residency status (dummy coded as Michigan or non-Michigan), sex (dummy coded as female or male). To make the data more parsimonious, non-significant variables were deleted from the model until the least number of significant variables that explained the most variance remained. Regression assumptions were tested by examining normal probability plots of residuals and scatter diagrams of residuals versus predicted residuals. Because multiple regression analyses are sensitive to outliers, potential influential outliers were examined using the studentized residual, Mahalanobis distance, and Cook's distance scores (Tabachnick & Fidell, 2007).

The regression model for GRE Verbal, cumulative science GPA, and age (transformed) on cumulative didactic GPA appears in Table 14. Preliminary analyses supported the hypothesis and indicated that no violations to the assumptions of normality, linearity, homoscedasticity, and independence of errors occurred. Interpretation of the first inverse coefficient illustrates that as student age decreased, there was a tendency towards higher cumulative didactic GPA after controlling for all other effects in the model. In addition, interpretation of the beta coefficients indicates that as GRE Verbal scores and cumulative science GPA increased, there was a tendency for mean cumulative didactic GPA scores to increase as well. In summary, the model containing age (transformed), GRE verbal scores, and cumulative science GPA explained 34.4% of the variance in cumulative didactic GPA among students in veterinary medical school.

Table 14.
Regression Analysis Summary for Traditional and Non-Traditional Admission Characteristics Predicting Cumulative Didactic GPA, after Removing Non-Significant Variables (N = 676)

Variable	B	SE B	β	t
Age (Transformed)	-.141	.053	-.099	-2.65*
GRE Verbal	.001	.000	.233	6.29**
Science GPA	.257	.044	.216	5.83**

Note. * $p < .05$. ** $p < .01$. $R^2 = .34$ (N = 676, $p < .001$).

Research Question 2

To what extent do traditional and non-traditional admission characteristics contribute to the prediction of cumulative grade point average (GPA) in the clinical portion of the veterinary medical school curriculum?

To determine if traditional and/or non-traditional characteristics contributed to clinical GPA, a linear multiple regression analysis was performed. The same variables selected as predictors for Research Question 1 were chosen for Research Question 2. Similarly, preliminary analyses were performed to test for regression assumptions of normality, linearity,

homoscedasticity, and independence of errors. Using the rules of parsimony, non-significant variables were deleted from the model until the least number of significant variables that explained the most variance remained. Again, potential influential outliers were examined using the studentized residual, Mahalanobis distance, and Cook's distance scores (Tabachnick & Fidell, 2007).

The regression model for the effect of age (transformed), ethnicity (dummy coded), GRE Quantitative, interview scores, and sex (dummy coded) on cumulative clinical GPA appears in Table 15. The overall test for the model was significant ($F = 10.761$, $df = 5, 675$, $p < .001$), explaining 27.1% of the variance in cumulative clinical GPA. Six cases were identified as potential outliers through case diagnostics; however, none of the cases exceeded the critical values for Cook's distance, the average leverage, Mahalanobis distance, or the covariance ratio. Therefore, none of the cases were deleted.

Interpretation of the first negative coefficient illustrates that as student age decreased, there was a tendency towards higher cumulative clinical GPA, after controlling for all other effects in the model. In addition, interpretation of the beta coefficients indicate that as GRE Quantitative and interview scores increased, there was a tendency for mean cumulative clinical GPA scores to increase. Furthermore, the inverse beta coefficients for ethnicity and sex indicate that White students and female students tended towards higher cumulative clinical GPA relative to non-White and male students.

Table 15.
Regression Analysis Summary for Traditional and Non-Traditional Admission Characteristics Predicting Cumulative Clinical GPA, after Removing Non-Significant Variables (N = 676)

Variable	B	SE B	β	t
Age (Transformed)	-.121	.027	-.169	-4.47**
Ethnicity	-.106	.028	-.141	-3.77**
GRE Quantitative	.001	.000	.080	2.11*
Interview	.009	.002	.137	3.63**
Sex	-.048	.024	-.076	-2.03*

Note. * $p < .05$. ** $p < .01$. $R^2 = .27$ (N = 676, $p < .001$).

Research Question 3

To what extent does cumulative didactic GPA contribute to the prediction of cumulative clinical GPA in the veterinary medical school curriculum?

To determine if cumulative didactic GPA contributed to clinical GPA, a simple multiple regression analysis was performed. The overall test for the model was significant ($F = 103.66$, $df = 1, 675$, $p < .001$), explaining 36.5% of the variance in cumulative clinical GPA. Interpretation of the beta coefficient illustrates that as cumulative didactic GPA increased, there was a tendency towards higher cumulative clinical GPA.

Research Question 4

Do group differences exist between students placed/never placed on academic probation in terms of admission characteristics or academic performance?

To examine if patterns of association existed between academic probation status and nominal admission characteristics, chi-square analyses were performed. Proportional distributions were compared across student ethnicity, prior degree, residency, and sex as a function of academic probation. Inspection of the findings indicated that no patterns of association existed (see Table 16). Next, to examine if interval or ratio admission characteristics

differed as a function of academic probation, independent t-tests were performed (see Table 17). A review of the results indicated that students placed on academic probation had significantly lower GRE Verbal and GRE Quantitative scores as compared to students never placed on academic probation. Similarly, students placed on academic probation had significantly lower cumulative science GPA as compared to students never placed on academic probation. Finally, to examine if cumulative didactic GPA and/or cumulative clinical GPA differed as a function of academic probation, two additional independent t-tests were performed (see Table 18).

Table 16.
Distribution of Non-Traditional Admission Characteristics as a Function of Academic Probation

	Probation *n = 36*		No Probation *n = 647*		
Characteristic	*n*	*%*	*n*	*%*	χ^2 (df)
Age Groups					
18 – 22	20	55.6%	395	61.1%	.43 (2)
23 – 28	13	36.1%	205	31.7%	
29 – 56	3	8.3%	47	7.3%	
Ethnicity					
White	30	83.3%	581	89.8%	1.51 (1)
Non-White	6	16.7%	66	10.2%	
Prior Degree[a]					
None	9	26.5%	133	20.9%	.72 (2)
Non-Science	3	8.8%	49	7.7%	
Science	22	64.7%	453	71.3%	
Residency					
Michigan	30	83.3%	480	74.2%	1.51 (1)
Non-Michigan	6	16.7%	167	25.8%	
Sex					
Female	31	86.1%	539	83.3%	.19 (1)
Male	5	13.9%	108	16.7%	

Note. The total sample size for Prior Degree is 669 because 14 participants were classified as "Other" and were treated as missing for this comparison.

Table 17.
Group Differences for Traditional and Non-Traditional Admission Characteristics as a Function of Academic Probation (N = 683)

	Probation $n = 36$		No Probation $n = 647$			
Characteristic	*Mean*	*SD*	*Mean*	*SD*	df	*t*
Age	23.44	4.56	22.98	4.08	681	- 0.67
GRE Verbal	473.89	85.30	507.71	89.37	681	2.22*
GRE Quantitative	608.06	86.94	644.71	77.96	681	2.73**
Interview	27.88	4.35	26.93	3.59	681	-1.52
Science GPA	3.19	.32	3.40	.39	681	3.16**

Note. * $p < .05$. ** $p < .01$.

Table 18.
Group Differences for Academic Performance as a Function of Academic Probation (N = 683)

	Probation $n = 36$		No Probation $n = 647$			
Characteristic	*Mean*	*SD*	*Mean*	*SD*	df	*t*
Didactic GPA	2.69	.34	3.18	.46	42.19[a]	8.15**
Clinical GPA	3.36	.23	3.47	.23	681	2.79*

Note. ** $p < .01$. [a]. A pooled t-test was used because the assumption of homogeneity was violated.

Summary

The information in this chapter reviewed the tasks and evaluation of data related to data preparation and screening, and the procedures used to merge cases into a single dataset. In addition, descriptive statistics for the dataset and tests evaluating assumptions of normality were described. Next, analyses used to evaluate sample equivalence were presented and the findings were interpreted. The research questions for the study were restated and appropriate analyses were performed.

The current research findings provided information on the characteristics at admission of veterinary medical students that predict performance in the didactic and clinical curricula. Regardless of any errors in the independent and dependent variables, it is intellectually satisfying

that significance was still found. Additionally, the study results provided insights that traditional characteristics at entry are predictive of didactic performance and a mix of traditional (e.g., GRE quantitative) and non-traditional (e.g., interview) characteristics are predictive of clinical performance. Finally, an interesting finding provided background for the trend that the younger students in the program tended to have stronger performances in the didactic curriculum.

The implications of the findings from this chapter deserve further discussion with attention given to future research opportunities that may contribute to the prediction of academic performance at key junctures in veterinary medical schools. It is worth noting that data tells us only so much and to find the remarkable relationships that were found is an exceptional accomplishment in this research. Recommendations are presented to assist veterinary medical colleges to engage in discussion about selection components utilize across the profession to select future veterinarians. Further, implications of these research opportunities, concluding thoughts, and a summary of this research are presented in Chapter Five.

CHAPTER 5

DISCUSSION, IMPLICATIONS, AND RECOMMENDATIONS

This chapter provides a discussion of the results and presents the conclusions, implications, and recommendations; these follow the research results. The first section provides a discussion of the key findings and their strengths as well as their consistency with previous research and the applicability of the conceptual models. In the second section, a summary of the conclusions is provided with a further discussion of the implications for the scholarship of admissions and its applicability to admission practices at veterinary medical schools. The conclusion consists of recommendations for future research. In this study, I expanded on the limited research available concerning the influence of traditional and non-traditional characteristics at admission and their relationship to performance in the veterinary medical school curriculum. Also, I explored the use of traditional and non-traditional characteristics, specifically, which of these predicted performance in the didactic and clinical curriculum.

Various scholars (Astin 1993; Pascarella & Terenzini, 2005) have researched and reported research based on undergraduate students and predictors of performance at time of college entry and have concluded that both input at entry and environment are directly related to performance in college (i.e., outcomes). Much of this reported research has focused on undergraduate students and not on graduate students or students in professional programs. Therefore, the current study sought to expand the application of this body of literature to veterinary medical school admissions. Sedlacek (2004) explored performance of college students as measured by non-traditional characteristics and found that certain non-traditional characteristics are predictive of performance. In other work, Wawrzynski and Sedlacek (2003) studied transfer students and their experiences. They posited that student success is significantly

related to their expectations; in particular, "when students' expectations are met, they are more likely to succeed, and when students succeed, they are more likely to persist" (p. 499). In summary, at the undergraduate and transfer level there are a plethora of research studies about predictors of success; however, in veterinary medicine, this type of research is lacking, thus the impetus for this study.

Purpose of the Dissertation

The purpose of this study was to identify characteristics found within an applicant pool of prospective veterinary medical students that predict academic performance in veterinary medical school during didactic and clinical curricula. The research literature reviewed assisted with the identification of variables for this study and their division into traditional and non-traditional characteristics. The identified traditional characteristics at entry were science GPA, and GRE Verbal and GRE Quantitative. The identified non-traditional characteristics at entry were interview score, age, gender, ethnicity, and residency.

This research study used the I-E-O model (Astin, 1993) and non-cognitive variables (Sedlacek, 2004) as the foundation for the analysis of the data. The population of interest was students admitted to MSU CVM from 2000 to 2006. The initial sample consisted of 744 MSU CVM students and, after correction of items due to error in data entry, the final sample resulted in 683 students. Regression analysis identified four variables as moderate predictors of didactic and clinical veterinary medical school GPA: (a) science GPA, (b) GRE Verbal, (c) Age, and (d) Interview Score.

Discussion of the Results

During data analysis of admission characteristics, two different pairs of characteristics were moderately predictive for each of the didactic and clinical GPAs: GRE Verbal and Science

GPA, and GRE Quantitative and the interview score respectively. Together, these four input variables were positive predictors of GPA during veterinary medical school curricula, but at different stages of the program.

The focus of Research Question One was to examine if traditional and non-traditional characteristics or input measures influence veterinary medical school didactic and clinical GPA. The results of the data analyses demonstrate that science GPA and GRE Verbal, as well as interview scores were positive predictors of performance in the curriculum (Table 14), which is a finding consistent with research conducted by Turnwald et al. (2001); in that study, they hypothesized that traditional characteristics (e.g., pre-veterinary science GPA and GRE) were predictors of performance during the didactic curriculum. Members of admission committees normally assess for these two characteristics to help with decisions about admission to veterinary medical school, and findings from this research study support the use of these characteristics as valid predictors of veterinary medical students' academic performance during the preclinical phase of the curriculum.

Academic success in college has much to do with students' input (grade and standardized tests) and the environment a college creates for students to live and study in (Astin, 1993). The findings with respect to Research Question One support the position that GPA is a strong predictor of admission decisions (e.g., Montecinos & Pohlman, 1987). In addition, the findings support research by Confer and Lorez (1999), who concluded that GPA and standardized test scores (STSs) have relatively high criterion-related validity with future GPAs. In veterinary medicine, the literature is limited about characteristics that predict performance during didactic and clinical curricula, but a study by Chastain et al. (2007) provides further evidence that pre-veterinary GPA was the best predictor of veterinary medical student success in the didactic

curriculum phase in that study. The findings in this research are further explicated below regarding traditional and non-traditional characteristics at entry.

Traditional and Non-Traditional Characteristics at Admission

In the current study, support was found for the use of traditional and non-traditional characteristics in admission decisions. Demographic characteristics for the MSU CVM cohorts being studied showed that most of the students were from Michigan, White, and female. When comparing females and males at entry, males had significantly higher GRE quantitative scores and significantly higher interview scores. These findings are consistent with previous literature, which found similar results (Kaczmarek & Franco, 1986). When traditional and non-traditional characteristics of White and non-White applicants at entry were examined, non-White students performed above their colleagues at entry during the interview. The use of the non-traditional interview variable score as a strong predictor of performance for women and minorities is consistent with work by Hughes (2002). Similarly, in allopathic medicine, Calkins, Arnold, and Willoughby (1987) found that for women, interview ratings and previous relevant experience were more predictive than previous didactic scores, and, for non-White medical students, the locus of control and self-evaluation were predictors of performance (Webb et al., 1997). The findings in the current study that non-White and non-Michigan residents performed higher in the interview and that their higher interview performance is a predictor of didactic academic performance suggests the beneficial role that the interview can have in the admission process for some students. Since the interview is a predictor of performance for some students (i.e., women and underrepresented students), it may serve as a tool to add diversity to an institution. Also, higher interview scores predicted better clinical performance.

Basco, Gilbert, Chessman, and Blue (2000) showed that interview performance was not predictive of clinical performance for human medicine students. However, in the current study, interviews were found to be predictive of clinical performance at MSU CVM, which is a critical and important finding for the veterinary profession. Since veterinarians, just like other healthcare professionals, must possess exceptional communications and interpersonal skills, assessing these skills is important and could be briefly and easily assessed during an interview.

It was also found that non-Michigan residents performed better than Michigan residents in the interview while Michigan residents were significantly more likely to be female than male. The higher scores on the interview by non-Michigan applicants at admission may be due to maturity and life experiences as Michigan residents were significantly younger at admission than non-Michigan residents. In addition, Michigan applicants with the highest science GPAs performed poorly in the interview when compared with applicants in other groups. This difference may be due to a lack of experience with interviews for the younger Michigan students. It is also worth noting that, at admission entry, non-Michigan residents had significantly higher non-traditional characteristics. Further, as GRE Quantitative and interview scores increased, there was a tendency for mean cumulative clinical GPA scores to increase. As noted earlier, the inverse beta coefficients for ethnicity and sex indicate that White and female students tended towards higher cumulative clinical GPA relative to non-White and male students. Also, Non-Michigan residents did not perform at higher level of academic performance than Michigan residents at both didactic and clinical curricula as measured by scores assigned using input from clinicians, other students, technicians, and animal owners considering such characteristics as communication, and ability to relate to others.

It was also revealed in the analysis that traditional characteristics at entry and at the completion of the didactic and clinical curricula were significantly higher for White students (Table 15). During the assessment of findings, the analysis demonstrated that ethnicity/race and sex were likely to predict clinical performance. Further, ethnic/race classification alone was a significant predictor of students' didactic performance in veterinary school. Given the expectation that all students would be equally successful because of the selective admissions process, these findings should be further investigated. Finally, the findings are similar to Astin's (1993) research and that reported by Pascarella and Terenzini (2005) that White students had significantly higher grades at the undergraduate level relative to non-White students. In general, clinical performance was predicted by both traditional and non-traditional characteristics at entry. However, in the current study, it was found that White and female students were predicted to have higher clinical GPAs than non-White and male students. In allopathic medicine, findings have demonstrated an association between clinical performance and interviews (Murden et al., 1978), while other studies reveal no relationships (Basco et al., 2000).

Traditional and Non-Traditional Characteristics as Predictors of Academic Performance

The second research question explored the extent to which traditional and non-traditional characteristics contribute to the prediction of cumulative grade point average in the clinical phase of the veterinary medical school curriculum. The findings in this portion of the study were derived by conducting independent sample t-tests, analyses of variance, and χ^2 independence tests. As might be expected, input characteristics such as GRE Quantitative and the interview score of admitted veterinary medical students were different at admission, and it is not surprising to see those differences persist in the results of outcomes after completion of didactic and clinical curricula. The reasons for such differences, however, are probably not unique to veterinary

medicine. On the other hand, it is the responsibility of institutions to ensure that accepted students will be successful irrespective of their entry characteristics. Further, accreditation essentials in veterinary medicine are changing to assess selection process, admitted students' retention, and graduation rates. Therefore, it is important to identify learning strategies that can be implemented for students prior to admission or early in the program. However, this is an opportunity to level the field by creating pre-enrollment programs for admitted students whose characteristics are so vastly different within the admitted cohort. This is not to say that students with less competitive traditional characteristics are worse than those with higher traditional characteristics, but such findings may provide the institution with information to create programs to prepare students for success.

This research study investigated inputs at admission at MSU CVM and their relationship with outcomes upon completion of the veterinary medical school curriculum. To clarify, applicants to MSU CVM, unlike applicants to many other professional programs (i.e., law, business, pharmacy, or some allopathic medicine programs) may be considered for admission without the completion of a baccalaureate degree. Applicants may apply to MSU CVM after the completion of two years of college (that is, at the junior level or third year of college). Applicants with the equivalent of two years of college who wish to apply to MSU CVM are considered without a college degree if the required science courses are completed (during the time of this study, MSU CVM requires 45 science semester credits for admission consideration). In the cohorts studied, such applicants were younger than applicants who already held a baccalaureate or a graduate degree. Contextual aspects of the environment were not included as assessment variables because these data were not collected. However, including such contextual aspects for analysis in future studies would be useful as it might provide answers to questions

relative to students' academic performance. Since characteristics at entry revealed the differences in the groups, establishing pre-entry programs for admitted students who are not as academically strong as their admitted counterparts could help reduce the differences as they move through the curriculum. The finding that younger students admitted to MSU CVM performed better academically than older students suggests that students' completion of science requirements closer to enrollment in the MSU CVM curriculum may influence performance. However, further investigation regarding the environment (i.e., financial aid, counseling, advising, mentorship, leadership involvement, and institutional culture) at the start and conclusion of the program would be helpful for future studies to consider.

No differences in performance in the didactic and clinical curricula were found as a function of sex. However, a difference in performance was found as function of ethnicity: White students performed at a significantly higher level than non-White students in didactic and clinical curricula, as measured by GPA. It is possible that these findings of differences in performance between these two groups can be explained as follows: (a) the majority of admitted students were White; (b) the non-White students may not have the support systems necessary to feel comfortable in a new environment as many of the non-White students were from other states; (c) the data indicated that non-White students were older than White students, and it is possible that being away from a science curriculum longer than their White counterparts precluded them from performing better (results indicated that younger admitted veterinary medical students performed better than older students in the curriculum); (d) the possibility of a long adjustment period in the new environment precluded them from engaging and performing as well as their White counterparts; and (e) it is possible that, since the majority of faculty were White, faculty as well as students did not know how to navigate their respective worlds due to cultural differences.

Furthermore, poor clinical performance of non-White students could have been the result of a hostile, unfamiliar, and culturally deficient clinical faculty who did not know how to interact with non-White students.

Work by Gurin, Dey, Hurtado, and Gurin (2002), among others, has espoused the view that diversity is of compelling interest at all levels, and they have eloquently observed that "helping faculty develop a pedagogy that makes the most of the diverse perspectives and student backgrounds in their classrooms can foster active thinking, intellectual engagement, and democratic participation" (p. 362). For faculty to not have these perspectives can hinder the teaching and learning experience. Indeed, colleges and universities should provide a supportive environment in which disequilibrium and experimentation can occur by increasing interaction among diverse peers and help faculty and students manage conflict when individuals share different points (Gurin et. al., 2002 p. 362). Finally, Sedlacek (2004) has demonstrated the role that strong support persons and community may play in helping non-traditional students be successful. At MSU CVM, students were mentored by other students, faculty, and practitioners; unfortunately, because the potential mentors, reflexive of the veterinary profession as a whole, are not very diverse, they may not have had the background or experience to provide needed assistance.

At MSU CVM, students were matched with a "big sib" or peer mentor who helped new students navigate the environment and were available to answer questions or provide support. Future research might want to examine the contributions of the big sib mentorship program to students' academic success. The findings do not suggest that White students will always perform better than non-White students or that preference in admission should be given to students of any group.

The findings relative to performance of White and non-White students, supports the inclusion of the assessment of traditional and non-traditional characteristics at entry. It is clear that if admissions were based only on traditional characteristics, it would reduce the diversity of the admitted pool. However, it is important to recognize that while these differences were present, students with lower scores on traditional characteristics did, on the whole, graduate on time and met the required GPA for graduation.

Wightman (1997) demonstrated that admission decisions based on traditional components would negatively impact the diversity of an applicant pool. More recently, Elmore (2003) provided a compelling account of the lack of racial diversity in veterinary medicine and the need for proactive recruitment and selection processes. In fact, limiting or excluding non-traditional characteristics during the admission selection can negatively impact the diversity of the veterinary profession. Finally, a possible reason for the differences in performance between White and non-White is that White students from Michigan, which were the majority of admitted students, were younger and might have completed science courses more recently than did the non-White students. As shown in Table 10, White students arrived to campus with significantly higher science GPA, GRE Verbal, GRE Quantitative scores, and were younger and predominantly from Michigan while non-White students at admission had higher interview scores. However, as mentioned above, the environment, which is a component of the I-E-O model, was not fully examined due to the lack of data on the environment. (To recap, environment refers to organizational factors such as support systems for students at the veterinary medical school that might include financial aid services, advising, mentorship, campus life, and other support systems.) Including various aspects of the environment in future research

of such populations should be assessed to determine if aspects of the environment have an influence on performance.

GRE Verbal and science GPA predicted approximately 34.4% of the sample variance (R) in didactic GPA and age was less likely to significantly predict didactic GPA performance. Of the three input variables, GRE Verbal was the most important predictor of didactic performance, followed by science GPA. These predictors of didactic GPA performance could be related to the emphasis in the didactic curriculum that requires completion of 18 to 22 semester credit hours with heavy reading, test-taking, and laboratory work. Students' performance in GRE Verbal may be indicative of their reading and critical analysis capabilities, which is likely to help them navigate large amounts of information, books, and journals and likely to help them in their performance in examinations and synthesizing information.

Additionally, performance in the didactic curriculum could be explained by the more recent preparation of some veterinary medical students through completing science courses shortly before enrollment in the veterinary medical school curriculum. Students who completed their science courses closer to enrollment in the veterinary medical school curriculum had an advantage over their colleagues as their science knowledge was more current and more easily accessible for the heavy and demanding science curriculum.

As noted above, age as a non-traditional characteristic was less likely to predict didactic performance. Nonetheless, in general, younger students have been known in science to perform better than older students in an intensive science curriculum. Their higher performance may be attributed to enrollment in science programs immediately after completion of these courses. While this may explain the current findings, it is important to note that majority of students in these data were younger than 28 years old. In fact, only 6.4% of the students were between the

ages of 29 to 56. As a result, this may actually be an artifact of the data and not generalizable. However, age as a predictor of higher cumulative clinical GPA is surprising, and it does not align with previous research findings. The higher the science GPA and GRE Verbal, the higher was the didactic GPA. Science GPA, GRE Verbal, and age moderately positively related to didactic performance. Interview score and age weakly positively related to clinical GPA and age was moderately inversely related to clinical performance. The finding that higher interview scores were predictive of clinical performance is validated by Chuck (2008) and Sedlacek (2004), who found that students in undergraduate, non-traditional, and minority populations with these non-traditional skills are successful and engaged in a variety of academic curricula.

It is unclear from the findings of this study why, as a student's age increased, a lower clinical GPA was predicted. Although the relationship between students' age and clinical GPA is unclear, one might speculate that some biases of expectations exist from clinical faculty and older students' performance. Perhaps the expectations for performance were set higher for older students than for younger students. In this research, the findings demonstrate that students who scored high on interviews were older, which supports research by Meredith et al. (1982) as well as by Murden et al. (1978). Although this literature may be dated, it still holds that performance in professional education over the years has become less reliant on the acquisition of declarative knowledge and incorporates interpersonal and motivational qualities more strongly. Perhaps, more students perform better during interviews due to more strongly developed interpersonal skills and motivational qualities. Interestingly, these findings did not translate into the clinical veterinary medical school curriculum for these students. Future research should investigate the traits and behaviors needed to be successful in the veterinary clinical environment. A better

understanding of these traits and behaviors would be useful to ensure greater success among all students.

Research on pharmacy doctoral students found that the personal attributes, which the interviews aim to assess, are directly linked as positive and essential in their performance (Doege & Assay-Eley, 2005). Additionally, in the current research, ethnicity/race and sex were important predictors of students' clinical performance. Students' interview scores at admission also contributed to academic clinical performance. Unfortunately, the interview score at MSU CVM was a total value rather than individual responses to each interview category. Therefore, it is unclear how specific personal attributes measured by interviews are related to students' performance.

Didactic Academic Performance as an Indicator of Clinical Academic Performance

The third research question explored whether didactic performance was a predictor in the clinical curriculum. The traditional and non-traditional variables used for this regression analysis were science GPA, GRE Verbal, GRE Quantitative, age, ethnicity, and interview. Regression analyses suggested that didactic GPA significantly predicts approximately 36.5% of the sample variance (R) in clinical GPA, and would predict approximately 13.2% of the population variance (Adjusted R^2). Higher didactic GPA predicted higher clinical GPA. Regression analysis indicated positive prediction of performance in the clinical when didactic GPA was high, which was expected.

The traditional and non-traditional characteristics at entry were very different for admitted students. There were incoming students who started the program with low science GPA, GRE Verbal, and GRE Quantitative scores in comparison with their counterparts with higher traditional characteristics. As this research study demonstrated, these three variables were

moderately to strong predictors of positive performance in the didactic curriculum. To assist students with less competitive admission scores, McMaster University in Ontario invests time and effort in their selection process and also offers 'remediation' support programs for students with academic deficiencies (Hughes, 2002). While this approach appears to work well for McMaster University, concerns about the constitutionality of admission processes at public institutions may limit its application in this country. Pre-entry enrichment programs might reduce the number of students placed on academic probation from the approximately 5.3% for the cohorts in the research study, and potentially improve retention. Currently, two medical schools (Newcastle, New South Wales; and McMaster University, Ontario) have demonstrated that careful selection and good support programs can have a positive impact on retention and graduation (Hughes, 2002).

In conclusion, the findings that didactic GPA predicted clinical performance is aligned with research findings that previous performance predicts future performance. Several studies (Clapp & Reid, 1976; Confer & Lorez, 1990, Confer et al., 1999) have demonstrated that previous GPA predicts future GPA for veterinary medical students. The relationship of the didactic performance as a predictor of clinical performance is contrary to findings in allopathic and osteopathic medicine. A study by Turnwald et al. (2001) reported that undergraduate GPAs were predictive of the first two years' performance for students in veterinary medical school, which support the findings in the current study that didactic GPA is predictive of clinical GPA in the veterinary medical school curriculum. Finally, this finding might be due the fact that the MSU CVM curriculum has deliberately included hands-on activities during the didactic curriculum that would allow future clinical students to learn using cases, problem-based learning, and clinical application before arriving to clinical rotations.

Traditional and Non-Traditional Characteristics that Predict Placement on Academic Probation

The fourth research question explored the question of whether differences existed between students placed or never placed on academic probation in terms of admission characteristics. It was important to examine characteristics that predict academic probation because (a) veterinary medical school is expensive for the student; (b) there is an investment of time, money, and resources on the part of both institution and the student when a student is placed on probation; and (c) there might be some characteristics identified via this study that could help in the selection of students to reduce the negative impact of being placed on academic probation. Additionally, when students are placed on probation, there is usually delayed program completion, which may have financial implications and may impact the psychological confidence about the students' ability to complete the degree or their preparation and skills at completion of the degree.

In order to investigate this question, a comparison of students as a function of academic probation was performed to determine if students who were placed on academic probation during their program differed in their input characteristics from students who were never placed on academic probation. Independent t-test analysis indicated that 36 students or (5.3%) of participants (n=683) in this study were placed on academic probation. These students had significantly lower GRE Verbal scores at admission than students never placed on academic probation. They also had significantly lower GRE Quantitative scores and science GPAs. Finally, the students who entered with lower traditional characteristics performed poorly in both the didactic and clinical portions of the curriculum; however, the negative performance was much more apparent in the didactic curriculum. At the end of their studies, students who had

been placed on probation had significantly lower didactic and clinical GPAs than those never placed on probation. This result could be a factor of the required or needed interpersonal aspects of performance as measured by faculty supervisors or mentors during the MSU CVM curriculum.

Finally, the research findings demonstrate that there is, statistically, a moderate relationship between traditional and non-traditional characteristics at entry with performance in the didactic and clinical curricula. However, in line with previous studies, the strongest predictors of performance for the didactic curriculum were science GPA and GRE Verbal. A positive relationship to performance in the clinical curriculum included GRE Quantitative and interview scores. It is important to note that there has been no previously published research regarding the predictive value of interview, age, residency, or ethnicity in the clinical veterinary medical curriculum; as a result, additional research related to the predictive value of non-traditional components on clinical GPA is warranted.

Evaluation of the Conceptual Models

Astin's (1993) I-E-O model and Sedlacek's (2004) non-cognitive variables were the models identified as the starting points for the design of the study. These provided a structure for understanding the traditional and non-traditional variables that influence academic performance during the didactic and clinical curricula in veterinary medical school. Astin's model assisted in guiding the research with respect to input variables at admission and outcomes variables at completion of the program. Sedlacek's non-cognitive variables model guided the research by identifying non-traditional variables at entry as possible influences during didactic and clinical curricula.

Sedlacek's non-cognitive variables work was included to guide the research design with respect to non-traditional variables assessed at entry, which were embedded in the interview tool used at MSU CVM. For the purpose of interviewing candidates for admission, MSU CVM Admissions Committee members used NCV categories based on Sedlacek's (2004) work to create a tool with categories important to the institution for assessment. More specifically, the NCVs included and examined as part of the interview tool were (a) knowledge of the veterinary profession; (b) leadership activities, and (c) community service. The findings from the current research supported the importance of the interview score as a contributor to clinical academic performance.

The models created for this study were designed to develop an understanding of what inputs at entry to a veterinary medical program influences academic performance in the didactic and clinical curricula and were found to be helpful in identifying factors that influence academic performance in the veterinary medical school curriculum. The model created for this study may be useful in designing future research into academic performance of students. Recommendations for future research are provided later in this chapter.

In the evaluation of Astin's (1993) I-E-O model, I examined individual traditional and non-traditional characteristics at admission as they related to my research questions. Astin's model suggested that students with strong traditional characteristics would have better academic performance in the didactic portion of the curriculum, which is consistent with other studies previously mentioned. The results of the current research support that position, while non-traditional characteristics were positive predictors of clinical academic performance.

Based on the findings of this study, the following conclusions about the relationship between input characteristics and relationship to performance in the didactic and clinical curricula were established:

1. The input characteristics of admitted veterinary medical students for the cohort studies at entry were Science GPA, GRE Verbal, GRE Quantitative, interview, gender, ethnicity, and residency status.
2. The majority of students in the sample were female, White, Michigan residents and most were young (18-22).
3. White students had significantly higher science GPAs, GRE Verbal, GRE Quantitative than non-White students but significantly lower interview scores.
4. Michigan residents had significantly lower interview scores and were significantly younger at admission.
5. The strongest predictors of didactic GPA at entry were science GPA and GRE Verbal.
6. Moderate predictors of clinical GPA were age and interview score.
7. Higher interview scores were predictive of clinical performance.
8. The characteristics of students placed on academic probation were a function of low science GPAs, GRE Verbal, and GRE Quantitative. They also had significantly lower didactic GPAs than students who were never placed on academic probation.

Implications

This research study confirms the importance of traditional characteristics as predictors of didactic performance and suggests a relationship between certain non-traditional characteristics and performance in some parts of the veterinary medical school curriculum. Findings in this study show the relationship that traditional and non-traditional characteristics have to veterinary

medical students' academic performance in the didactic and clinical curriculum (Tables 14 and 15). From the research findings, it can be seen that students admitted with high traditional and non-traditional characteristics performed better academically than those who had lower traditional and non-traditional inputs at entry. Additionally, at entry, admitted veterinary medical students with higher scores on traditional and non-traditional characteristics were less likely to be placed on academic probation. These findings are important because, as veterinary medical schools review admission criteria, they may consider identifying processes to select students who are less likely to be placed on probation and more likely to complete the program. Furthermore, since the AVMA COE has indicated an expectation for accreditation that schools will maintain both technical/traditional skills and non-technical/non-traditional skills, the findings that both characteristics contribute to the performance of veterinary students is helpful. Finally, as the cost of veterinary medical education continues to increase, it is important to establish traditional and non-traditional thresholds for academic success and program completion. Cost of attendance to and completion of a veterinary medical program are forecast to be important accreditation essentials. Veterinary medical schools should be at the forefront of creating an environment for reducing student debt and for creating a tool that demonstrates that assessment at entry is appropriate for yielding better performance of graduates.

Admissions professionals, deans, administrators, and admission committee members should consider how to identify criteria for admission and what characteristics to include as criteria for admission to yield the desired outcomes. Is there a way institutions of higher education can implement admission criteria and thresholds that will prevent students' placement on academic probation? Because AVMA COE expects graduates to be prepared with exceptional traditional and non-traditional skills, it is important for institutions to seriously

evaluate the tools they use in admission selection. It is important, then, for administrators and faculty to work collaboratively to identify best policies and practices for admission selection in veterinary medical schools. As we know, the application process is highly competitive, and tuition is expensive at veterinary schools in the United States. The implementation of sound, well-orchestrated, and well-researched admission criteria will only help to create and implement appropriate admission criteria.

Finally, admissions professionals, administrators, faculty members, and deans are continually evaluating the best admission practices at their respective schools. However, the evaluation and implementation of these practices are implemented with an awareness that institutions are unable to invest sufficient time in this process because faculty members do not have much spare time for service. The evaluation of traditional input components such as science GPA and STRs are easily quantifiable and assessed without much investment of time on the part of faculty and administrators. The challenges encountered are the time and cost needed to assess NCVs via written or verbal communication (e.g., letters of recommendation or the interview). Unfortunately, in many programs, there has been a tendency to eliminate interviews due to concerns about their validity, reliability, and legality. The reliability and validity of interviews have been called into question as it compares to other traditional components with higher precision (Kreiter, Yin, Solow, & Brenna, 2004). Overall, leaders in the field of veterinary medicine should consider how the inclusion of non-traditional characteristics in the admission selection process would positively benefit the profession.

Recommendations for Future Research

It is widely acknowledged that admission selection is neither science nor art. What is known is that implementing the right selection polices to select the best and brightest health care

professionals are critical to serve society and animals. As noted in Chapter Two, much of the research on academic performance has been conducted at undergraduate institutions, allopathic and dental schools, and other professional programs. In veterinary medicine, the most comprehensive study was completed by Confer et al. (1999) almost 15 years ago and that only examined the contribution of traditional characteristics to didactic performance. Additional research studies on the performance of veterinary medical students in didactic and clinical curricula and the characteristics that predict performance would extend the findings of the current study and create a platform for further discussion on the future of admission selection characteristics for veterinary medical schools.

At present, it would be important for admissions officers at veterinary medical schools to include in their assessments of applicants the use of GRE, GPA, and interview since this study focuses on one school only and findings from this study must be interpreted with caution. Applicants should be encouraged to apply and enroll in veterinary medical school upon recent completion of their bachelor's degree or, for those with no completed degree, to enroll in science refresher courses prior to admission. To assess whether such selection methods are appropriate at other veterinary medical schools in the United States, I recommend conducting similar studies using past admitted cohorts and evaluating the performance and retention of students admitted. Finally, veterinary medical schools are encouraged to monitor the performance of students during the didactic curriculum and provide supportive services to students who are not performing well. This monitoring measure might assure good clinical performance and experience.

As the results of this study directly relate to the program at MSU CVM, it is important to conduct additional research comparing the cohorts admitted in 2000 through 2006, when

interviews were part of the assessment process, with the performance of subsequent cohorts starting in 2007 through the present, when interviews were not included. A study comparing the two groups would assess any differences in performance during the didactic and clinical curricula of these two groups..

Furthermore, I recommend that the Association of American Veterinary Medical Colleges (AAVMC) champion a large national study that (a) examines selection methods at veterinary schools, (b) organizes schools with similar admission criteria for the study, and (c) identifies a particular school that will have the responsibility for the research project to examine the characteristics at admission (input) that predict academic performance (outcomes) in the didactic and clinical curricula at veterinary schools across the United States. In addition, I recommend that this endeavor be a longitudinal study because that would provide the basis for assessment over a period of time, which would enhance the study's validity and reliability for others to replicate. Moreover, I strongly urge that quantitative and qualitative methodologies be used to assess characteristics that predict academic performance in veterinary medical schools. Finally, the data can be used to conduct a multiple-year study on graduates and their performance once in practice. Astin's (1993) I-E-O model and Sedlacek's (2004) NCV work should be used for this proposed study as frameworks to guide it. While I was not able to include environmental factors in this study, I suggest such variables be examined in future research to delineate specific variables that influence academic performance. Specifically, the inclusion of environmental factors influencing academic performance would be useful because placement on academic probation was not a function of groups by ethnicity, age, or residency, so it was unclear why these students were on probation. Perhaps personal challenges, illness, finances, or other factors

influenced being placed on academic probation. However, without the examination of the environment, it is difficult to conclusively determine the causes.

In summary, this chapter included a restatement of the purpose of this study, a discussion of the results with highlights of the characteristics predicting didactic and clinical performance at MSU CVM, the traditional and non-traditional characteristics of participants in this study, the results of the predictive value of traditional and non-traditional characteristics, and limitations of and recommendations for future research. This study validates the importance of traditional characteristics as a predictor of didactic performance and confirms that certain non-traditional variables are predictive of performance in veterinary medical school. It is hoped that characteristics identified in this study to predict a certain level of performance are utilized to formulate policy at the MSU CVM and to create intervention programs that will help limit the likelihood of placement on academic probation. Since this research provides solid evidence of characteristics that predict performance, pre-enrollment programs can be created to help students prior to entry to maximize success in a rigorous veterinary medical school curriculum.

APPENDICES

APPENDIX A

ADMISSION SELECTION FORMULA AT MSU CVM

MSU CVM considered the factors listed below in the admissions process to the Doctor of Veterinary Medicine:

Five Steps in the Admission Selection Process	
Step I	*Scholastic Indicator Score*: Cumulative Grade Point Average (GPA), GPA required for Math and Science, GPA for last 45 Credit Hours, MCAT or GRE Scores
Step II	Secondary Application
Step III	File Review
Step IV	Interview
Step V	Final Selection
	Scholastic Score (10%)
	File Review (40%)
	Interview (50%)

APPENDIX B

VETERINARY MEDICAL SCHOOL CURRICULUM

Goals of the New Curriculum
(Implemented 9/2/92)

1. Modify instruction to emphasize principles rather than esoteric details.
2. Make learning interactive using technology where appropriate.
3. Integrate both vertically and horizontally what is taught.
4. Reduce lecture time and use diverse teaching methods to stimulate lifelong learning.
5. Give greater visibility to non-practice career options through new applied clerkship experiences.

BASIC VETERINARY SCIENCE

(2 1/2 years – 5 semesters)
Phase I – Normality
Year 1

Semester 1 (Fall)		
ANS511	Animal Science for Veterinarians	2 (2-0)
PDI515	Comparative Veterinary Gross Anatomy	6 (2-10)
PDI516	Veterinary Histology & Cell Biology	4 (3-2)
MMG561	Veterinary Immunology	2 (2-0)
SCS511	Veterinary Radiology	1 (1-0)
VM511	Veterinary Perspectives (VP) I	2 (1-2)
VM512	VIPS I*	1 (1-0)
		18 (12-14)

Semester 2 (Spring)		
ANS513	Animal Nutrition for Veterinarians	2 (2-0)
PDI517	Veterinary Neuroanatomy	1 (1-0)
MMG567	Veterinary Microbiology and Infectious Diseases I	5 (4-3)
PSL511	Veterinary Physiology	5 (5-0)
PDI551	General Pathology	3 (2-2)
VM521	Veterinary Perspectives (VP) II	2 (2-0)
VM522	VIPS II*	3 (3-0)
		21 (19-25)

Phase II – Abnormality

Year 2

Semester 3 (Fall)		
MMG569	Veterinary Microbiology and Infectious Diseases II	5 (4-3)
PHM556	Veterinary Pharmacology	5 (5-0)
PDI553	Clinical and Systemic Pathology	5 (4-2)
VM532	VIPS III*	3 (1-4)
VM533	Veterinary Epidemiology	3 (3-0)
		21 (17-9)
Semester 4 (Spring)		
PHM557	Veterinary Toxicology	2 (2-0)
VM541	Veterinary Perspectives (VP) III	2 (2-0)
VM542	VIPS IV*	3 (2-3)
VM543	Cardiovascular Diseases	2 (2-0)
VM544	Veterinary Public Health	2 (2-0)
VM545	Principles Anesthesia and Surgery	4 (3-2)
VM546	Musculoskeletal Diseases	5 (5-0)
VM547	Respiratory Diseases	2 (2-0)
		22 (20-5)

The 4-year professional program leading to the DVM degree requires completion of 163 semester credits with an overall GPA of no less than 2.0.

Phase III – Intervention and Prevention

Year 3

Semester 5 (Fall)		
VM552	VIPS V*	3 (2-3)
VM553	Theriogenology and Urinary Diseases	5 (4-2)
VM554	Hematological, Oncological and Dermatological Diseases	3 (3-0)
VM555	Neurological and Ophthalmological Diseases	3 (3-0)
VM556	Digestive, Metabolic and Endocrinological Diseases	5 (5-0)
VM557	Operative Surgery	2 (1-3)
		21 (18-8)

* *VIPS – Veterinary Integrative Problem Solving*

- *Capstone course for the semester.*
- *Integrates material taught for that semester.*
- *Non-lecture format.*
- *Problem-solving focus.*
- *Designed to utilize communication skills.*

CLINICAL AND APPLIED VETERINARY MEDICAL SCIENCE

(Years 3 and 4 – Semesters 6, 7, 8, 9)

Professional students must complete 33 required clerkship credits and 27 credits from elective clerkships and other approved courses. Students may take up to 3 vacation blocks of 3 weeks each.

Each clerkship will be 3 weeks and 3 credits.

REQUIRED CLERKSHIPS (33 credits)

Students must complete the following required clerkships:

LCS620 Equine Clinical Clerkship I
PDI630 Diagnostic Pathology Clerkship
SCS611 Diagnostic Imaging Clerkship
SCS625 Small Animal General Medicine Clerkship
SCS626 Small Animal Soft Tissue Surgery Clerkship
SCS646 Small Animal Orthopedic Surgery Clerkship
SCS647 Small Animal Internal Medicine Clerkship
SCS648 Anesthesia Clerkship
SCS695 Emergency and Critical Care Medicine Clerkship

Students must also select one experience from each of the following pairs of clerkships:

LCS621 Equine Practice Clerkship
or
LCS631 Food Animal Practice Clerkship
LCS630 Food Animal Medicine & Surgery Clerkship
or
LCS647 Concepts in Agricultural Practice Clerkship

ELECTIVE CLERKSHIPS (27 credits)

Students planning to use more than 6 elective credits in any clerkship toward graduation requirements must request approval from the CVM Curriculum Committee. All clerkship schedules are subject to the approval of the Professional Programs Coordinator.

PDI610 Veterinary Gross Anatomy Dissection
PDI611 Research Problems in Veterinary Anatomy
LCS627 Advanced Equine Medicine Clerkship
LCS628 Techniques in Equine Anesthesia and Surgery
LCS632 Adv Food Animal Medicine & Surgery Clerkship
LCS638 Beef Production Medicine Clerkship
LCS639 Small Ruminant Medicine & Mgmt Clerkship

LCS640 Large Animal Anesthesia Clerkship
LCS641 Food Animal Theriogenology Clerkship
LCS646 Equine Neonatal Medicine Clerkship
LCS677 Veterinary Preceptorship (off-campus)
LCS678 Government & Corporate Veterinary Practice
LCS680 Food Animal Techniques
LCS681 Food Animal Production Medicine 1
LCS682 Food Animal Production Medicine 2
LCS683 Food Animal Production Medicine 3
LCS690 Veterinary Public Health Field Experience Clerkship
LCS691 Veterinary Public Health Research Clerkship
MMG690 Veterinary Microbiology Clerkship
PHM658 Research Problems in Pharmacology or Toxicology
PDI631 Necropsy Clerkship
PDI632 Problems in Veterinary Pathology
PDI634 Endocrinology
PDI635 Special Problems in Path/Histopath & Cytology
PDI636 Aquatic Medicine
SCS613 Diagnostic Ultrasound Clerkship
SCS637 Operative Surgery: Instruction and Review
SCS640 Cardiology Clerkship
SCS641 Comparative Ophthalmology Clerkship
SCS642 Zoo & Wildlife Medicine Mgmt Clerkship
SCS644 Dermatology Clerkship
SCS651 Adv Comparative Ophthalmology Clerkship
SCS670 Small Animal Clinical Nutrition
SCS690 Veterinary Molecular Biology Clerkship
SCS693 Problems in Small Animal Clinical Sciences
SCS693a Small Animal Theriogenology
SCS654 Oncology
SCS655 Clinical Surgical Oncology Clerkship
SCS694 Small Animal Specialty Practice (off-campus)
VM611 Veterinary Externship Clerkship (off-campus)
VM690 Special Problems in Veterinary Medicine
VM692 Career Development and Business Skills
LCS610 Problems in Large Animal Clinical Sciences
LCS610 Wildlife Disease Ecology and Management
LCS611 Research Problems in Large Animal Clinical Sciences
LCS613 Clinical Problems in LCS (off campus)
LCS614 Equine Clinical Proficiency Clerkship
LCS615 Equine Emergency and Critical Care Clerkship
LCS622 Equine Clinical Clerkship II
LCS623 Equine Musculoskeletal Diseases Clerkship
LCS624 Equine Theriogenology Clerkship

LCS625 Equine Herd Health Clerkship
LCS626 Advanced Equine Surgery Clerkship

APPENDIX C

REQUEST FOR DATA FROM MSU CVM DEAN

Hilda Mejia Abreu, PhD Candidate – HALE
207 River Ridge
Boerne, TX 78006
hildamejiaabreu@gmail.com
(517) 589-0859

October 4, 2012

Christopher Brown, Dean
College of Veterinary Medicine
Michigan State University
G 100 Veterinary Medical Center
East Lansing, MI 48824

Dear Dean Brown,

I am working to complete my doctoral dissertation at Michigan State University, College of Education in the Higher, Adult, and Lifelong Learning (HALE) program. The study is entitled "Evidence-Based Admissions: Correlates of Students' Academic Success in Veterinary School." As part of this study, I am requesting to review data from the 2000-2006 admitted cohorts of students to the Michigan State University Veterinary Medical School. The entire study will be provided to Michigan State University College of Veterinary Medicine to inform admissions practices.

All information and data from the study is confidential. Admitted students' data for cohorts 2000-2006 will be coded by the institution to maintain confidentiality and protect the College as it relates to Family Educational Rights and Privacy Act (FERPA) that safeguards privacy of students. Dr. James Lloyd, Associate Dean and Professor at the Veterinary Medical School is a member of my dissertation committee and will assist with facilitation of protecting these data.

Further, there are no risks associated with participating in this study. Students' data will be coded for protection. The benefits of conducting this study include the increased knowledge concerning evidence to conduct admission selection processes that might identify characteristics for success in veterinary medical school.

I will be analyzing data collected and will protect data for this analysis consistent with university IRB guidelines and protocols. Data have already been collected at the institution through the Office of Medical Education Research and Development (OMERAD) as the director of the OMERAD collaborated with me during my employment at MSU as assistant dean for Admissions & Student Services.

I can schedule a time via Ms. Terrie Bunn, executive assistant to clarify any concerns and answer any questions you have related to this request.

Thank you for considering this request.

Sincerely yours,

Hilda Mejia Abreu

CC:
Dr. Matthew Wawrzynski, HALE Professor and Dissertation Chair
Dr. Marilyn Amey, HALE Department Chair, Professor, and Dissertation Member
Dr. John Dirkx, HALE Professor and Dissertation Committee Member
Dr. James Lloyd, Veterinary Medical School Professor, Associate Dean for Budget & Planning
Dr. Coretta Patterson, Veterinary Medical School Associate Dean for Academic & Student Affairs

IRB Documents/Request for Data Dean Brown/10/4/

APPENDIX D

INTERVIEW QUESTIONS AND SCORING GUIDE

Introductory comments:
The purpose of the interview is to allow us to gather some information that is not available anywhere else in your application packet. At the end of the interview, time will be allotted for you (candidate) to ask questions about the college, the veterinary profession, MSU, or the surrounding community. **[Be sure to inform the candidate that if he/she does not feel comfortable with a particular question, he/she reserves the right not to answer.]**

Please use at least one question during the interview process for each of the categories below. Feel free to paraphrase or use your own style of questioning.

Interviewers are asked to use candidates' information from their application to formulate questions for each category.

Opening Questions:

Why MSU CVM? (*Objectives: introduction, get to know the applicant, start the conversation, to allow the applicant to feel comfortable*)

1. Why MSU CVM?
2. What particular event or events led to your decision to become a veterinarian?
3. Why did you select veterinary medicine over other health professions or scientific fields?
4. What is it about the veterinary profession that is most appealing to you?
5. What was the most meaningful (or most difficult) veterinary/animal related event you have experienced?

Knowledge and insight gained through reported experience with animals:

(Objectives: to identify knowledge of behavior, management, and basic health care of animals)

1. What are the roles of veterinarians in creation of a safe food supply?
2. Is there a particular species that interests you?
   Why is this species of interest to you?
   Could you describe the aggressive behavior in specie of your choice? What are the signs of aggressive behavior in _____?
   How would you handle an animal showing aggressive behavior?

Knowledge of and insight gained through reported veterinary related experience:

(Objectives: awareness of current standards, trends, and opportunities within the profession)

1. What are some of the current challenges that veterinarians face? How might those change in the future?
2. What are some of the career options/choices that are open to you with a veterinary degree?
3. Describe a typical day in the practice or laboratory or workplace where you spent time and describe your responsibilities.
4. What is the role of the veterinarian in:
   Production animal medicine (food animal production)?
   Laboratory animal medicine?
   Public Health?
   (use candidates' information to ask these questions)

5. How do veterinarians share information and remain current in their profession?

Problem-solving skills

(Objectives: to assess candidate's ability to identify the problem, resourcefulness, logical approach, communicate the challenge clearly, and to use internal and external perspective)

1. **Scenario:** Select from several possibilities as time permits. Also, be sure to use candidate's application to create these questions. Each scenario may explore different aspects of the candidate's knowledge base and background.
    a. Example: How would you deal with a disease that can be transmitted from wild animals to domestic animals and from animals to humans?

Knowledge and understanding of the importance of the role of a professional to society and community:

(Objectives: to assess potential for leadership in community, outreach, and professional involvement)

1. What is the role of a veterinarian in his/her community?
2. What are some local, national, or international issues in which veterinarians may play an important role? How might you deal with them?
3. What are some of the new roles that veterinarians are undertaking in our changing world (bio-terrorism, food safety, government, etc.)?
4. What do you plan to contribute to your community and society within 5 years of graduating from veterinary school?

Motivation and Enthusiasm:

(Objectives: to assess coping techniques, personal drive, determination and general enthusiasm)

1. Describe a situation in which you had to make a personal sacrifice to reach a goal.
2. What are some sacrifices you might have to make to succeed in veterinary school?
3. If not admitted to veterinary school, what is your plan?
4. You are admitted to veterinary school and you failed your first exam or your loan/scholarship was not processed, how would you handle this situation?
5. Five years after graduation, what personal goals would you have liked to have met?

Life Experiences:

(Objectives: to assess self-reflectiveness, maturity, ability to face reality, tenacity, and ability to bounce back)

1. What do you consider the most difficult task you will be asked to accomplish in veterinary school, and what personal characteristics do you posses that will assist you in accomplishing this task?
2. Describe a situation in which you had to work with/interact with someone you did not like? How did you manage to accomplish the tasks?
3. Describe a situation in which you felt overwhelmed (by work/by school/by personal events). How did you cope at that time? What did you learn from the situation?
5. Please discuss the most rewarding activity in which you have participated during college or work experience and provide details about this activity.

6. Over the past several months, the media has covered several national or international issues or areas of conflict give an example of one these conflicts and discuss your resolution strategies.

Presentation skills, interpersonal communication, and overall impression of the candidate:

1. Based on your overall impression of the candidate, please rate each category: 1-5.

APPENDIX E

FACULTY INTERVIEWERS' TRAINING

MEMORANDUM

TO: CVM Faculty Interviewer's Workshop

FROM: Dr. Lorel Anderson, Chairperson, Committee on Student Admissions
Ms. H. Mejia Abreu, Director, Office of Admissions

RE: CVM Faculty Interviewers' Workshop: Thursday, February 10, 2005

Welcome back! Congratulations on being selected as a faculty interviewer this year and thank you for your participation in this very important process of the College of Veterinary Medicine. Your contribution in selecting the next generation of students and future colleagues are appreciated by the CVM community and the profession.

Every year, the CVM Office of Admissions in collaboration with the Committee on Student Admissions makes improvements to the Interview Process in an attempt to make it more structured and valid. In addition, every year we offer an interviewers' training. The interviewers' training will be held on Thursday, February 10, 2005 in room A174 VMC from 10:00 a.m. to 2:00 p.m. Again, Dr. John Molidor will be our trainer.

CVM Faculty Interviewers are required to attend this workshop. Please see attached registration form to be returned to Ms. Patricia Peterson, curtis@cvm.msu.edu, marked either attending or will not be attending this workshop. Please confirm your attendance by January 21, 2005.

If there are questions, please call 3-9793.

Thank you and we look forward to seeing you at the workshop

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