ASSESSING CHANGES IN COMPETENCY OF FOURTH-YEAR VETERINARY MEDICAL STUDENTS FOLLOWING A DEFINED CLINICAL EXPERIENCE

A Dissertation

by

NOBERTO FRANCISCO ESPITIA

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

May 2008

Major Subject: Agricultural Education

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Approved by:

Chair of Committee,	Kim E. Dooley
Committee Members,	John R. August
	James R. Lindner
	Timothy H. Murphy
Head of Department,	David Wm. Reed

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ABSTRACT

Assessing Changes in Competency of Fourth-Year Veterinary Medical Students Following a Defined Clinical Experience. (May 2008)

Noberto Francisco Espitia, B. S., Texas A&M University;

M. S., Texas A&M University

Chair of Advisory Committee: Dr. Kim E. Dooley

The purpose of this study was to measure the competency of problem solving skills of fourth-year veterinary students. The study identified two primary objectives, (a) define clinical competency for fourth-year veterinary medical students, and (b) construct an instrument to assess the student's level of clinical competency.

A faculty advisory panel identified three themes in the development of a definition of clinical competency, (a) competency was situational, (b) competency was described by ability, and (c) the definition of fourth-year student competence was descriptive within the context of primary patient care. The description of competency contributed to the establishment of parameters applied to the rubric.

Student self-assessments were taken twice; initially at the beginning of the clinical rotation, and again at the end of the rotation as a post-clinical assessment. The faculty instructor provided a comparison post-clinical assessment to serve as an authentication of the reliability of the instrument.

Overall, students qualified themselves to be “Fully Competent Students” at the beginning of the clinical rotation, and also at the end of the rotation. However, in the disaggregated quantified scores, the student self-assessment peaked at the highest competence level, “Among The Most Competent Students,” for five descriptors of values and beliefs listed under Responsibility, Professionalism, and Interpersonal Skills. The faculty comparison assessment was in agreement with the student’s qualified description as “Fully Competent Students” but did not agree with the higher quantified scores posted for values and beliefs.

The descriptive statistics of the data reflect that the mean increased between the pre-clinical ($M = 8.43$, $SD = 1.36$) and the post-clinical ($M = 9.10$, $SD = 1.32$) assessments. The comparison mean for the faculty assessment ($M = 9.01$, $SD = 1.52$) was slightly lower than the student post-assessment.

The assessment provided evidence supporting a confidence statement that the instrument has the sensitivity to detect changes in skills, and is consistent with research validated measures of problem-solving skills. Faculty authentication provided evidence of intra-rater reliability, while statistical analysis provided evidence that a relationship appears to be present between live-patient animal instruction and the increase in problem-solving competence of fourth-year veterinary students.

DEDICATION

This is dedicated to my wife, Maria Del Carmen, my most loyal supporter, the source of my inspiration, and the standard bearer for our family.

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I readily admit that I probably would not have made this attempt except for the encouragement and assistance of my friends, and the members of my family. I owe each a great debt of gratitude for their support and confidence in me as I labored to complete the curriculum. I want to begin here, to thank them.

I want to thank, and express my sincere gratitude, to my committee chair, Dr. Kim E. Dooley, for accepting me as her student. Dr. Dooley was a teacher, a mentor, and a professional role model of exceptional caliber. I want to thank also my committee members, Dr. James R. Lindner, Dr. Timothy H. Murphy, and Dr. John R. August for their guidance, and the sharing of their experience as academics and researchers. I especially want to communicate my appreciation to Dr. August for his sincere interest in my success, and for his unselfish promotion to others of my potential to succeed in new efforts. He is a great friend.

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I am very grateful for the assistance and advice I received from Measurement and Research Services, specifically Dr. Mark E. Troy, and his graduate assistant, Andrew Slaughter. They provided invaluable assistance in creating a Web-page to host the research instrument, and were exceptionally helpful with the formatting, reporting, and analysis of the research data.

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Last, but most important to me in all respects, I thank my wife, Maria Del Carmen, and our family, for their encouragement, their support, and their unwavering dedication to my success. Lest anyone should ever mistake this achievement to have been an individual effort, let it be known that I never have labored alone.

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CHAPTER I

INTRODUCTION

During the last half of the 20th century, the theory and practice of education underwent great change. For many professionals, education was seen as a force in shaping American society. Many of the changes in education were created by advancements in technology, science, and industry; others were politically directed as a consequence of societal evolution in mores, values, and philosophy. Within educational institutions, changes often incorporated more than the adoption of new methods or different theories. With increasing frequency, the usual criteria were expanded to include measures of improved quality and enhanced accountability (Wooliscroft, Tenhaken, Smith & Calhoun, 1993).

Programmatic changes began to appear during the decades of 1970 and 1980. Private industry and corporate business began to adopt Total Quality Management as an operational tool (Trent, 2002). As the decade of the 1990's turned, educators began responding to concerns brought forward by political, societal, and governmental stakeholders. Outcomes assessment began gaining a prominence as an evaluation tool to assist in assuring compliance with the standards and expectations of the various interest groups (Patterson, 2006) (Walsh, Osburn & Schumacher, 2002).

This dissertation follows the style and format of the *Journal of Agricultural Education.*

Within the health care/health science professions, outcomes assessment has become an important compliance criterion that is evaluated during accreditation review. Accrediting agencies are increasingly concerned with how professional medical, dental and veterinary schools are measuring and assessing clinical competency of new graduates. The American Veterinary Medical Association (AVMA) has issued the requirement that "veterinary graduates must have the basic scientific knowledge, skills and values to practice veterinary medicine, independently, at the time of graduation. At a minimum, graduates must be competent in providing entry-level health care for a variety of animal species" (AVMA-CVEA Std. 21.11.3, 2007). Included with the instructions is the requirement that the schools and colleges develop relevant measures examining nine competency areas to validate scientific knowledge, skills, and values.

Although the AVMA requirement to measure clinical competency is clearly stated, the method is neither identified nor agreed upon throughout veterinary medicine. In fact, it is more often stated that competency is presumed rather than defined (Walsh, Osburn & Schumacher, 2002). For veterinary colleges across the United States, the emerging question became, how is competency defined and how is it measured?

The defining experience of veterinary medical education and clinical instruction at Texas A&M University is presented to veterinary students during their fourth year of study in the professional curriculum. All students enrolled in the veterinary medical curriculum spend their final year in the Veterinary Medical Teaching Hospital (VMTH), an interdepartmental service unit of the College of Veterinary Medicine and Biomedical Sciences (CVM-BS).

The College of Veterinary Medicine was originally established in 1916 as the School of Veterinary Medicine, a unit of the Agricultural and Mechanical College of Texas. It has grown to be one of the largest colleges in the United States and graduates an average of 125 veterinarians each year (CVM-VTPB Web-page). The VMTH functions as a competency-based clinical teaching laboratory and is recognized as an established leader of instruction, patient care (service), and research in veterinary medicine. In Fiscal Year 2005 (FY ending 31 Aug 2005), the Small Animal Clinic logged 13,342 patients for evaluation and treatment. During the same period the Large Animal Clinic logged 77,395 patients for evaluation, treatment, or herd health management (VMTH medical records).

The VMTH provides the clinical platform for student learning in large animal, small animal, and mixed practice career tracks. Fourth-year, senior students, select the career track of their choice and develop their professional skill base by participating in the diagnostic evaluation and treatment of privately owned animals admitted as patients in the VMTH large or small animal clinics. Students select clinical rotations in 12 instruction blocks; each block lasting four weeks with two clinical rotations lasting two weeks. The curriculum includes a four week externship block to gain experience in private clinical practice and governmental agencies external to the CVM-BS. All students, regardless of career track, complete clinical rotations in core curriculum instruction in anesthesiology (large and small animals), radiology (large and small animals), and surgery (large and small animals). The three clinical blocks amount to one quarter of their final year of veterinary school and forms the backbone of their skill base development and practical experience. The remainder of the fourth-year curriculum is constructed upon elective clinical rotations within the large and small animal clinics.

The American Veterinary Medical Association (AVMA), through its Council of Education (COE), has initiated a requirement that the CVM-BS, and all other veterinary medical institutions, develop a process and method to evaluate the professional skills base and level of clinical competency of its students at graduation. To satisfy the AVMA requirement, veterinary colleges must be able to validate through empirical evidence that new graduates possess the skills and cognitive reasoning to treat patients competently and compete successfully in private veterinary practice.

Statement of the Problem

The CVM-BS fourth-year curriculum is broadly dispersed, with multiple internal and external variables affecting student contact with patient animals. Reliance on the general population of pet owners and ranchers to provide animals for teaching and development of clinical skills contributes to uncertainty in predicting veterinary student uniformity in performance outcomes. Arguably, four consistent variables having impact on teaching and learning outcomes include (a) the inability to control or effect year-round presentation of patient animals, (b) the offering of multiple career track curricular options requiring a broad base of species-specific patient animals, (c) elective options for clinical rotations (at least 50% of the total clinical experience) generating institutional competition for specialty service support and faculty, and (d) faculty recruitment shortfalls impacting the year-round availability of board-certified specialists in every referral service across the entire VMTH.

Referral services constitute the mainstay of clinical experience for fourth-year students and provide the most challenging cases suited for higher order learning and competency development. Collectively, the referral services present a diverse and clinically enriched learning environment for students. Students participate actively in discipline-specific problem-based learning, and receive individual mentoring from faculty clinicians generally acknowledged as being experts in their discipline.

Clinical diversity is also manifested through individual teaching philosophy and style, instructional design, and individual standards for learning outcomes. The AVMA directly addresses the preference for diversity in its accreditation criteria (AVMA-COE Std. 9.9, 2008). Diversity, however desirable, is being balanced by the requirement that veterinary colleges develop relevant measures to validate clinical competency in specified skills. The identified problem is that the CVM-BS currently does not have an established method or system to measure the clinical competency of students during the fourth and final year of veterinary college.

In response to the requirement for the development of relevant measures that address clinical competence, this study addressed the measure of patient diagnosis problem-solving skills.

Purpose of the Study

This study was precipitated by practical necessity. Changes in the American Veterinary Medical Association criteria for accreditation of veterinary colleges require evidence of measurable outcomes in nine separate clinical competencies. The purpose of this study was to develop a means to measure the competency level of diagnostic problem solving skill of fourth-year veterinary students. The concept identified two primary objectives of the study. First was the need to define clinical competency for veterinary medical students entering professional practice and qualify the principal variables affecting student learning and development of AVMA mandated skills. Second was the need to construct a rubric to measure and assess the student's level of clinical competency prior to entry into professional practice.

Method

Analysis of the problem identified the following process to accomplish the primary objectives of the study:

- Receive approval and buy-in of the Dean, College of Veterinary Medicine and Biomedical Sciences, and academic department heads, to initiate a research study within the professional curriculum.
- Establish a five member, clinical expert, faculty advisory panel as consultants about professional veterinary medicine and clinical competency.
- Develop a rubric acceptable to veterinary faculty and students that is descriptive of skills applied to clinical diagnostic problem solving.

- Evaluate comparisons of student self-assessment scores using a *t*-test for correlated samples repeated measures.
- Calculate a Pearson product-moment correlation coefficient (*r*) to determine the relationship of the student's self-assessment of the pre-clinical competency with the post-clinical competency. Determine if evidence of a relationship exists between live-patient animal instruction, and improvement in veterinary student problem-solving skill.
- Determine an effect size index for *r*, and a coefficient of determination, r^2, to reflect the proportion of common variance affecting the student and clinician measurements.

Theoretical Base of Study

The theoretical foundation of this study was supported by research and scholarship in adult learning, competencies, outcome-based assessment, problem-based learning, and self-directed learning.

The veterinary medical student body (all classes) presents a well defined example of the adult learner model commonly described within the scientific literature. The average student is 25 years old and generally possesses adult life experiences including several years of workforce background, or varied combinations of backgrounds (CVM-BS pre-admission data). The veterinary college selection process reflects a preference for students who demonstrate an experiential background rich with evidence of life-centered learning. Supportive adult learner theory includes work by Lindeman describing five assumptions that (a) adults are motivated to learn as they experience needs and interests that learning will satisfy, (b) adults' orientation to learning is life-centered, (c) experience is the richest resource for adults' learning, (d) adults have a deep need to be self-directed, and (e) individual differences among people increase with age (Knowles, Holton, & Swanson, 1998, p.71).

The development of clinical competency for fourth-year veterinary students is heavily dependent on experience gleaned from situational exercise solving problems associated with naturally occurring disease in patient animals. Now known as Problem-Based Learning (PBL), some of the earliest theoretical findings were reported by the Canadian education system during the 1950s (Gijbels, Dochy, Van den Bossche & Segers, 2005). Descriptors of PBL includes, (a) dependence upon real problems that require learners to acquire knowledge, (b) construct solutions for developing problems, and (c) collaborate with others to address new problems or secondary effects that may arise as a result of actions applied to the primary problem (Majeski & Stover, 2005). Originally developed as an instructional tool of medical educators, PBL today is widely applied by other professional disciplines including law, economics, and liberal arts (Moust, Van Berkel, & Schmidt, 2005).

A notable component of problem-based learning includes the expectation that students possess individual discipline as self-directed learners. The first (1967) to report on self-directed learning was Tough (Merriam, 2001). His study concluded that self-directed learning was an everyday part of life, that it was systematic but had no physical reliance on the classroom (Merriam, 2001). Widespread professional interest in self-directed learning was catalyzed as a result of Tough's research. A contemporary model introduced by Grow (1991, 1994) has subsequently gained wide recognition as Staged Self-Directed Learning (SSDL). The SSDL model is based on the theory that learning is situational. The learner is expected to transition between being self-directed in one problem experience, and become a dependent learner in another problem experience. However, once the aspects of self-directed learning have been experienced they remain transferable (Grow, 1991). Student adaptation to problem situations is weighted by their learning strategies and self-regulation in learning.

Measuring the acquisition of knowledge, and verifying the ability to apply knowledge, ranks among the highest priorities of public education today (Walsh, Osburn, & Schumacher, 2002). The present challenge to the CVM-BS, and this study, is the lack of universally accepted assessment tools that are applicable to the clinical environment and which will forecast future performance reliably (Shaffer, Gordon, & Bennett, 2004). Included among the needs is a well defined statement of expectations of students. Effective assessment cannot be conducted if the objectives have not been clearly defined (Walsh, Osburn, & Schumacher, 2002). Addressing these needs is the purpose of this study.

The challenge in assessment extends further than the agreement or disagreement upon the availability of tools. The discussion expands to include agreement on appropriate definition and description of competency. In many professional disciplines, veterinary medicine included, the term competency can be descriptive of art form and altruistic behavior as much as it is descriptive of science and skill (Boursicot & Roberts, 2006). Questions remain unanswered, disagreements incompletely settled, about what indicators accurately reflect quality of education and competency. The findings of clinical competency assessment in the Michigan State University College of Veterinary Medicine (MSU-CVM) included the non-specific and subjective nature of the faculty assessment of student skills, and lack of specific criteria (Patterson, 2006). The study conducted at Texas A&M University, College of Veterinary Medicine and Biomedical Sciences (CVM-BS), in 2007 was sensitive to the weaknesses described in earlier research and took steps to address the specific questions referencing the definition and measurement of competency.

Research Question

1. Does a relationship exist between clinical competency and student experience with patient animals?
2. What evidence exists, and how can it be measured, to validate that veterinary graduates are competent to enter professional practice at the time of graduation?

Importance of Study

The overarching motive for this study is precipitated by a mandate originating from the American Veterinary Medical Association, Council of Education (AVMA-COE), requiring that the CVM-BS produce evidence of student learning outcomes for clinical competencies. The requirement specifically addresses the need to employ direct measurement methods.

This study will add to the body of knowledge for theory of agricultural education and veterinary medical education. Improvement in teaching methods, the development of performance outcomes, and improvement in outcome assessment are domains that share common importance for veterinary medical and agricultural science based disciplines. The role of the modern veterinarian includes livestock production, domestic animal health and zoonotic disease control, food safety and health technology, human and animal disease control, and laboratory animal research; all of which are rooted in traditional agricultural science and share in the history of educators and researchers.

The practical significance of this study will be its immediate applicability as a CVM-BS source record of compliance with the requirements set by the AVMA-COE. This study has further potential to be shared with other schools of veterinary medicine and applied as a model for developing their own designs and methods for measuring student learning outcomes at their institutions.

Theoretical significance is found in the immediate short–term potential to (a) validate the strength of the curriculum and method of instruction currently in use in the CVM, (b) identify needs for change to strengthen or enhance the curriculum, and (c) develop criteria to re-prioritize existing programs. Long-term theoretical significance includes providing an instrument for veterinary medical educators to quantify learning in a clinical setting, increase recognition of clinical faculty for success in the scholarship of teaching, and make contribution to the existing theory of problem-based learning.

Delimitations

This study was delimited to fourth-year veterinary medical students enrolled at Texas A&M University, College of Veterinary Medicine and Biomedical Science, graduating class of 2008, who voluntarily agreed to participate in a self-assessment of problem-solving skills. Student sampling included only those students who gave informed consent for their participation.

Limitations

Conditions contributing to or describing limitations of this study included the following:

- Population demographics, specifically gender distribution, are abnormally skewed in favor of female students.
- Random sampling designs could not be utilized. The professional veterinary curriculum is practicum-based with career tracks pre-selected by students as much as two years in advance of assignment to the clinical rotation.
- Sample sizes could not be adjusted by design or improved by design. Students who are assigned to a rotation or a block of instruction are determined by curriculum requirements and limitations, not by experimental design.
- Treatment effects could not be manipulated or influenced by the study. The problem under study was dependent upon the clinical presentation of random disease manifested by the general population of animals. Every disease and associated problems will have a different challenge variable and every patient being presented must be treated with full consideration of health, safety, and well-being of the animal.

Basic Assumptions

The following assumptions were considered to be present and available for this study to go forward:

- Every student assigned to a clinical rotation would be presented with a patient case for evaluation and treatment.
- Clinical service groups and clinicians available to be included in this study would be willing to participate in the evaluation and grading of the problem solving skills.
- Necessary CVM resources and system infrastructure required for assistance with preparing, conducting or scoring tests (i.e. pre-test, post-test administered on-line) would be made available and offered for support.

CHAPTER II

REVIEW OF THE LITERATURE

Increasingly, institutions and programs of all descriptions and at all levels across society are finding they are being questioned or tasked to validate the finished quality of their product. In the case of education, the academic institutions are being held accountable for the learning and competency of the graduates of their respective programs. This study relied upon a literature reviewed in five major subject matter areas, including adult learning, problem-based learning, self-directed learning, outcomes-based assessment, and competencies.

Adult Learning Theory

The professional veterinary medical curriculum is a rigorous and intellectually demanding program that covers four years of intense study grounded in traditional science. The program selects for students who have completed at least one undergraduate degree and possess life experiences that demonstrate first-hand knowledge of veterinary medical practice. The average student entering veterinary school is 25 years old and is generally credited with adult life experiences including several years of workforce, or any variety of combinations.

During the 1920s, the study and development of adult learning theory began to emerge and take root among educational researchers. Key contributors to adult learning theory included Thorndike, recognized for advancing learning theory through rigorous scientific methods of investigation, and Lindeman, credited with advancing knowledge using intuition and analysis of experience (Knowles, Holton, &

Swanson, 1998). Listed among Lindeman's contributions to the theory of adult learning are five assumptions stating (a) adults are motivated to learn as they experience needs and interests that learning will satisfy, (b) adults' orientation to learning is life-centered, (c) experience is the richest resource for adults' learning, (d) adults have a deep need to be self-directing, and (e) individual differences among people increase with age (Knowles, Holton, & Swanson, 1998, p. 71).

A student's beliefs about the nature of knowledge and of learning, termed epistemology, directly affects the motivation to learn which in turn affects the learning outcomes. The relationship between motivation, life experience, life-centeredness, and learning has been examined in a number of studies that collectively reinforce the assumptions in Lindeman's theory (Paulsen & Feldman, 1999). Goal orientations, intrinsic and extrinsic, were reported to have a direct effect on academic performance; intrinsic goals tend to enhance performance while extrinsic goals tend to constrain performance (Paulsen & Feldman, 1999).

By 1970, the study of adult learning was being identified through distinct terminology, referred to as andragogy, and development of theoretical assumptions that clearly identified the characteristic. A prominent theorist among the researchers was Knowles, who constructed six assumptions of an adult learning model over a thirty-year period. These six assumptions include (a) the need to know, (b) the learner's self-concept, (c) the role of the learner's experiences, (d) readiness to learn, (e) orientation to learning, and (f) motivation (Knowles, Holton, & Swanson, 1998).

Prior to 1980, the emphasis of adult learning was focused on the individual. About that time, the six assumptions of the adult learning model began to receive re-examination by researchers in the field; notably among those was Knowles himself. The underlying reason for re-examination being that educators were in debate about whether the definitions of andragogy were applicable to adult learners only, and whether andragogy was a theory of education or a description of how adult learners should be defined. Early in the decade of the 1980's, Knowles began making a transition in his assumptions that andragogy was separate from pedagogy, to a position that represented both as belonging to a continuum extending from teacher–directed to student-directed learning. This re-position acknowledgement by Knowles promoted the re-emphasizing of andragogy more by the learning situation than by the learner (Merriam, 2001).

Adult learning theory expanded further in 1967 with the introduction of self-directed learning by Tough (Merriam, 2001; Ross-Gordon, 2003). Self-directed learning theorized that adults were proponents of exercising individual control in learning. Contemporary description of the theory has expanded to include the thought that it may be a situational variable rather than a permanent learner characteristic (Ross-Gordon, 2003). Further expansion of the theory now includes the description formulated by Grow (1991, 1994) as the Staged Self-Directed Learning model. The SSDL model describes four stages of roles that transition between the learner and the teacher (Ross-Gordon, 2003).

Self-Directed Learning

A component of the educational experience in the veterinary medical curriculum is the implied expectation that students be self-directed learners. The first comprehensive description of self-directed learning was introduced in 1967 by Tough. His study of 66 Canadian adult learners reported that learning by adults is wide spread, that it is an everyday part of life, and that it is systematic but has no physical reliance on the classroom (Merriam, 2001). Tough's research is credited as being the catalyst for generating widespread professional interest in self-directed study.

The current literature reveals a great deal of activity within the field. Models, processes, situations, and conditions remain on top of the list of topics being investigated and written about as researchers try to refine theories and focus effort. A contemporary instructional theory model that has gained recognition is the Staged Self-Directed Learning (SSDL) model introduced by Gerald Grow (1991, 1994). The SSDL model identifies four stages of student self-directed learning behavior and instructor interaction relative to the student, and the instructor's role in facilitating the student to fully attain self-directed learning behavior.

The SSDL model is based on the theory that learning is situational. The learner may transition between being self-directed in one problem experience, and become a dependent learner in another problem experience. However, once self-direction is established, certain aspects are transferable to new situations (Grow, 1991). How students develop self-directed learning skills and how well they adapt to different problem situations is weighted by their learning strategies and their degree of self-regulation (Ertmer, Newby, & MacDougall, 1996). In a qualitative study of how veterinary students approached learning from a problem-based perspective, Hmelo-Silver (2004) reported that students with high self-regulated learning strategies valued learning from problems and focused on analysis and reflection. In contrast, low self-regulated learners in problem-based instruction had difficulty adapting. One of the conclusions of the study was that low self-regulated students may experience difficulty with the implied self-directed learning requirements of a problem-based curriculum.

The application of self-directed learning within curricula has generated discussion, even debate, about definition of the term, and misapplication or misunderstanding of the process by educators and students alike. Research within problem-based learning curricula in particular has pointed out the difficulties experienced by faculty and students in understanding role responsibilities in self-directed learning settings (Miflin, 2004). Frequently the misunderstanding being reported is the interpretation confusing self-directed learning with self-teaching (Miflin, 2004). Some students reportedly express resentment that they are expected to assume the role of subject matter expert and undertake their own instruction.

Problem-Based Learning

The concept and method of problem based learning (PBL) as it is identified today has been credited to the Canadian education system beginning in the 1950s (Gijbels, Dochy, Van den Bossche & Segers, 2005). Applied originally to medical education curricula, it has expanded and found wider application to other disciplines in health sciences, law, economics, and liberal arts (Moust, Van Berkel & Schmidt, 2005).

Described as an instructional strategy, PBL relies upon (a) examination of real problems constructed to require learners to acquire knowledge, (b) solve the developing problems, and (c) collaborate with others to address new problems or secondary effects that may arise as a result of actions applied to the primary problem (Majeski & Stover, 2005). In an article reporting PBL in gerontology, Majeski and Stover (2005) describe the learning process as collaborative and active. Learning tasks of the students include the following, (a) identify important facts and issues related to the problem, (b) formulate ideas about concepts related to the problem posed, and to the different disciplines that relate to the selected (gerontological) issue, (c) identify what knowledge and information are needed to address the problem, (d) further develop concepts and facts about different aspects of the problem, and (e) formulate new learning needs related to the problem, and to the social science disciplines.

The literature abounds with varying definitions and descriptions of PBL (Gijbels, Dochy, Van den Bossche & Segers, 2005). However, six core elements common to the definition of PBL have been described in a model developed by Barrows (1996). These are: (a) learning is student-centered; (b) learning occurs in small groups; (c) a tutor is present as a facilitator or guide; (d) authentic problems are presented at the beginning of the learning sequence, before any preparation or study has occurred; (e) the problems encountered are used as tools to achieve the required knowledge and the problem-solving skills necessary to eventually solve the problems; and (f) new information is acquired through self-directed learning (Gijbels, van de Watering & Dochy, 2005). The desired outcome of PBL is to “guide students to become experts in a field of study, capable of identifying the problems of the discipline and analyzing and contributing to the solutions" (Gijbels, Douchy, Van den Bossche, & Segers, 2005, p. 30) and to "develop problem solving in two dimensions: the acquisition of knowledge and the application of knowledge" (Gijbels et al., p. 30).

In the theoretical model, PBL begins with a problem designed by the instructor that is challenging, realistic in context, and is not easily solved but is designed to have a desired outcome. Central to the problem and the problem-based learning educational method, is the problem-solving process described by five characteristic steps that include, (a) observation or information gathering, (b) questions, ideas, and hypothesis formulations, (c) learning issues or inquiry strategy, (d) actions plans, and (e) reflection (Berringer, 2007).

A second model utilizes four steps to negotiate the problem-solving process and is significantly different only in that it places stronger emphasis on the first step, defining the problem. In this model for non-standard problem-solving (problems that require application of domain knowledge and routines), the four steps are referred to as crucial episodes that reflect distinct categories of behavior. The four crucial episodes are, (a) analyzing the problem, define the problem clearly, (b) selecting appropriate knowledge, explore, (c) create and implement a solution plan, and (d) check the answer or verify against the question asked (Harskamp & Shure, 2007).

In the naturalistic setting describing the VMTH-Small Animal Clinic, the instructor designed problem is replaced by a live-patient animal manifesting a naturally occurring disease or injury. Replacement of the theoretically designed problem by the naturally occurring problem would arguably serve to heighten the problem-solving educational experience rather than detract from the experience. Following the introduction of a problem-based learning curriculum at the University of Tennessee College of Veterinary Medicine, it was reported that additional skills considered important for veterinary professionals included communication, problem analysis, critical thinking, and decision-making skills (Howell, Lane, Brace, & Shull, 2002). In the description of the first-year curriculum, the authors relate that case scenarios for teaching were developed further to introduce topics related to professional behavior, ethics, and economics.

Clinical instruction at the CVM-BS at Texas A&M University is principally discipline based. The clinical setting, however, replicates a problem-based learning educational experience centered on real problems that require effective problem-solving abilities. A representative schematic of the problem-based/problem-solving experience for a fourth-year veterinary student is presented in Table 1.

Table 1

Alignment of the Veterinary Student Problem-Based/Problem-Solving Experience

PBL Core Elements	Student Experience In 4th Yr. Clinics	Problem-Solving Process
(1) Real problems encountered.	Live-patient disease & injury.	Observation, information gathering, define problem.
(2) Student-centered learning.	Students work & manage clinical cases.	Learning issues, explore, discuss ideas.
(3) Learning occurs in small groups.	Approx. 4-5 students in each group.	Share ideas, synthesize new knowledge, peer assist.
(4) Tutor or facilitator present.	Individual instruction by faculty clinician.	Create action plans & implement solutions.
(5) Problems are tools to knowledge.	Patient health status provides knowledge tools.	Make inquiry, develop strategy, select knowledge.
(6) Self-directed learning, obtain new knowledge.	Review case history/ current literature, interact with peers & faculty.	Reflection, verify results, hypothesize.

Assessment

Determining the acquisition and application of knowledge by learners has become one of the highest priorities of public education, private industry, and governmental agencies at all levels (Walsh, Osburn, & Schumacher, 2002). Aside from institutional or statutory compliance, the primary reasons given for the development of an assessment is to enable an organization to be successful in achieving its stated goals and meeting its mission objectives (Trent, 2002). Trent further states that the purpose of assessment is to improve educational programs (when conducted in context with learning) as demonstrated by the achievement of the students (2002). The essential component to this line of thought is definition of the school's expectations of its students. Effective outcome assessments are not likely to be conducted, or determination made that the graduates are meeting the objectives, if the objectives have not been clearly defined (Walsh, Osburn, & Schumacher, 2002). The challenge currently facing the medical profession, human and veterinary, is that it lacks universally accepted tools that can be used to evaluate the supporting components of medical education to gauge their impact on the quality of medical practice over the course of an individual's career (Shaffer, Gordon, & Bennett, 2004). The scarcity of tools is itemized descriptively as;

> Medical education-and the field of medicine more generally-lacks a standard, replicable set of metrics for determining how different individuals perform across the range of abilities needed for clinical practice: knowledge of medicine, analytic and diagnostic skills, perceptual and motor skills, interpersonal skills,

and perhaps most important, clinical wisdom and judgment (Shaffer et al., 2004, p. 170).

Among the tools that are needed are reliable means for assessment measures and feedback from students, and educator willingness to place the student at the center of the learning and teaching process (Taras, 2002). According to Taras (2002), establishing the needs and learning requirements of the student focuses the learning process onto the student.

Difficulties and disagreement within the academic community arise when the conversation about assessment includes student participation in the assessment process, and with the selection of methods for providing feedback to the students. Assessment and feedback are seen as defining characteristics of tradition-oriented educators; these characteristics contribute to reluctance to share or assign responsibility to students (Taras, 2002). Similar difficulties were reported for a study of a self-assessment strategy for community nursing students in England. In that study it was reported that the development of a self-assessment strategy was “fraught with difficulties in negotiating the introduction with faculty colleagues” (Fitzpatrick, 2006, p. 41). In contrast with that position, Sadler (Taras, 2002) proposes that self-assessment (by students reviewing their own work using intellectual processes equal to their instructor’s) is required to complete the feedback loop. The concept extends further to propose that feedback occurs when the learner who is receiving it is obligated to actively participate in the process and apply the information learned to reduce gaps in knowledge that exist between the stated reference level and the level actually identified.

Proponents of self-assessment reference the need for students to develop as independent learners, maintain the pace with evolving curricula, and to satisfy the expectations of the general public and employers (Cassidy, 2006). Among the conclusions cited by Fitzpatrick (2006, p. 50) are student comments describing “a sense of achievement and growth in personal and professional autonomy.” The report elaborates further that self-assessment strategy in the community nursing programs made contribution to the students’ development and application of critical-thinking skills.

Perhaps one of the more important and immediate effects to be realized from student self-assessment is the positive response in self-directed instruction. While the argument might be made that self-directed learning leads to self-assessment, in particular as a direct result of a situational need commonly associated in medical or veterinary patient care, research does support that the two behaviors are interactive and once learned, tend to be life-long (Gruppen, White, Fitzgerald, Grum, & Wolliscroft, 2000).

Competency

The review of literature addressing competency in any number of professions seems to begin invariably with a qualifying statement alerting the reader that universally accepted assessment tools are lacking or disagreed upon. The difficulty can be particularly troublesome within the medical and professional health care fields, including veterinary medicine, because many consider competency to be an art form as much as it is science and skill. More often than not institutional emphasis is placed on the more scientific and easier-to-articulate technical aspects of defining competency than on the more humanistic “art” form that medical (and veterinary medical) undergraduates require to develop into competent practitioners (Boursicot & Roberts, 2006). Expanding on the dichotomy, Boursicot & Roberts (2006) commented that societal expectations drive the institutions to make explicit the objectives and to specify the details for each stage of advancement; conditions that normally run counter to the clinician's subjective interpretation of student capability.

Complicating the problem further is the active debate among the various stakeholders, including program directors, clinicians, students, and the public at large in trying to determine what indicators accurately reflect quality of education and competency. Research has been conducted and surveys created in an effort to identify common traits or qualities representative of competent practitioners. One such survey was constructed by the Association of Program Directors in Internal Medicine's Research Committee (APDIM) using a modified Delphi process to define indicators of quality in internal medicine training (Klessig et al., 2000).

The survey included selected requirements of the Residency Review Committee-Internal Medicine (RRC-IM), perceptions and belief systems of faculty and residents, and 16 potential indicators of quality suggested by Cohen (president of the Association of American Medical Colleges). Each item was rated using a five-point Likert-type scale to measure importance as an indicator of the quality in residency training programs. A total of 44 items were included in the instrument, 34 focused on the training process and 10 dealt with outcomes measurement. The questionnaire was distributed to 418 program directors and an unspecified convenience sample of medical residents.

The reported results focused on the educational process more than the outcomes of training. What was evident was that there was a diverse opinion of what was viewed as quality indicators of training. A significant finding was that there was little in accord between the RRC-IM and what the responders considered important. Although residents and faculty were highly correlated in their choices of items rated most important, they were strongly contrasted in the single item rated most important (variety of clinical rotations offered), which was not rated by the faculty among their top choices. The overall conclusion was that more fact finding and investigation should be conducted to determine what training indicators would best represent the interests of the majority of stakeholders.

In a survey of second-year veterinary students enrolled in the Michigan State University College of Veterinary Medicine (MSU CVM), assessment was made to determine improvement in clinical reasoning skills (Patterson, 2006). The variable of interest was the student's self-confidence in making problem lists, making rule-out lists, and selecting appropriate diagnostic tests. The methodology involved students self-rating their confidence on the first day and last day of a 15-week semester. Changes in the student's self-confidence were analyzed through subjective faculty assessment of student competence in the three skill areas.

Students' competence in performing the three reasoning skills seemed to improve. However, weaknesses in the assessment were reported. This was attributed to the non-specific and subjective nature of the faculty assessment resulting in an inability to correlate student self-confidence and the ability to perform specific reasoning skills. Student inability or inexperience in self-assessment was also questioned as a possible weakness of the study. Lastly, faculty did not have specific criteria or a rubric available to judge the quality of student's problem lists and rule-out lists. The author critiqued that the study required a targeted and multifaceted assessment of competence through out the semester to improve objectivity of skill development.

CHAPTER III

METHODS AND PROCEDURES

This chapter describes the research design used in the study, including the selection of subjects, instrument design and utilization, data collection process, and methods used to analyze the data.

Research Design

This study focused on assessing student performance of "comprehensive patient diagnosis," one of nine clinical competencies identified by the American Veterinary Medical Association-Council Of Education (AVMA-COE) to be self-evaluated by the College of Veterinary Medicine and Biomedical Sciences (CVM-BS) as part of its academic accreditation review. Elements contained within this competency include problem solving skills, appropriate use of clinical laboratory testing, and records management. The design included the formation of an expert panel of five veterinary medical clinicians to serve as consultants for the duration of the study. All panel members were faculty with full-time permanent appointments in the Department of Small Animal Clinical Sciences (VSCS). Each panel member was purposely requested for their academic experience or expertise, and for the diversity of clinical specialization characteristic of their professional discipline. The expert panel's primary responsibilities specifically included, but were not limited to, helping to define clinical competency, and describing elements of a rubric to measure and score student problem solving skill exhibited during the student's clinical rotation.

The fourth-year veterinary medical curriculum is based on a clinical practicum involving treatment and care of naturally occurring disease in live-patient animals. The limits and application of the research design were strongly influenced by conditions set by the clinical practicum. The practicum is developed during the fall semester of the student's third year of professional studies. Early in the third year, each student is required to declare a career track preference and construct an individual course of study for the final year of veterinary school. The resultant clinical studies plan becomes the individual's fourth-year practicum experience. The fourth-year practicum, irrespective of career track selections, involves 22 clinical rotations instructed in-residence at the Veterinary Medical Teaching Hospital (VMTH) and two rotation periods in a non-residence status identified as professional development externships. Each clinical rotation normally includes four to six students assigned to a specialty service group receiving professional clinical instruction under the direction and supervision of a faculty veterinarian. Students learn by providing diagnostic services and veterinary medical care to patient animals admitted to their clinical service group and assigned to them personally for treatment and care.

This research was designed as an abridged Systems Approach Model of Educational Research and Development (R&D) extending across successive clinical rotations (Gall, Borg & Gall, 1996). A rubric was developed to measure student clinical competency reported as a descriptive statistic relationship of improvement in problem solving skill resulting from the live-animal experience gained during the clinical rotation. The estimate of the duration of the data collection period in the "best case scenario" was eight rotations before the minimum number of 30 students and clinical patient interactions would be attained. Timeline predictions could never be more accurate than an estimate due to the inability to control the distribution of participating students (those agreeing with informed consent) within each rotation; a research design limitation that was established by the student's selection of career track and course electives made the previous year.

Selection of Participants

The participants for this study were recruited with informed consent (Appendix A) from the fourth-year veterinary medical class of 2008. The entire class (129 total students) was addressed in person and recruited collectively during a mandatory assembly for pre-clinical orientation conducted the week preceding entry into the fourth-year curriculum. Voluntary participation was the first and most highly valued element of the selection criteria because it established credibility for the accuracy and reliability of the self-assessment measurement. Attaining the desired minimum student sample number (n = 32) was entirely dependent on the willingness of fourth year students to self-assess their clinical problem solving skills. The recruitment effort netted 59 volunteers.

To capitalize on the advantage gained by a high volunteer rate, the sampling strategy had to consider and identify student preference for clinical service assignment, then target those services for sampling of volunteers throughout the academic year. Equally important was the need to identify an individual faculty clinician who would agree to permit the survey to be conducted during their assigned blocks of clinical instruction, and who also had primary (academic grade) responsibility for student instruction during the clinical rotation. The pairing of the faculty clinician with the volunteer students was an essential component of the design. Sampling would occur only when the clinician and the volunteer students were scheduled on the clinical rotation simultaneously. This requirement essentially satisfied the conditions of a purposeful sampling strategy (Gall, Borg, & Gall, 1996). Last, to avoid disruption of the normal regimen for patient care and clinical instruction, the students who had volunteered (the sample group) were permitted to access a Web-page allowing asynchronous completion of the self-assessment rubric during the first two working days of the rotation. This condition proved to be a powerful incentive for the faculty instructor and the students to participate in the study.

The General Surgery service emerged as the single clinical service in the VMTH able to forecast the maximum number of students volunteering to participate in the study, and which identified a faculty instructor willing to participate as an evaluator for the study.

Instrumentation

The objective of this study was to develop an instrument to measure and assess the student's clinical diagnostic problem solving skills. The focus was on the student's cognitive ability to recall existing knowledge and reassemble it with new information obtained through physical examination and care of patient animals presented for surgery. Assessment also included selected behavioral attributes that have influence upon clinical decision making including professionalism, interpersonal skills, and responsibility (Shaffer, Gordon, & Bennett, 2004).

The data were collected using a rubric (Appendix B) developed specifically for the assessment of the veterinary student's problem solving skills. Skill bases involving cognition and value mediated behavior were targeted. Psychomotor skill was intentionally not included as a component of the rubric. The decision to omit psychomotor skill as a rubric domain was based in the premise that veterinary students receiving instruction in surgery are observed, assessed, and measured daily on their applied skills, techniques, and procedures. Numerous measures, including successful live-patient surgery and post-surgical healing and recovery, exist already which offer evidence of an individual's competence in psychomotor skills.

Rubric Design

The rubric listed twelve performance measures for skills involving cognition and personal values and beliefs in the clinical problem solving process. Contained within each of the twelve performance measures was a sub-listing of associated performance tasks that defined and qualified the student's competency level. Each performance task was scored across a graduated scale representing four levels of increasing competency. The four competency levels were identified as (a) Less Than Minimally Competent

Student, (b) Minimally Competent Student, (c) Fully Competent Student, and (d) Among The Most Competent Students. Each competency level was assigned a three-point range of scores to quantify the degree that the student's decision making met the description of the performance task within the competency level chosen. The score range increased incrementally by three points as each higher competency level was obtained. The full range of scores began with a minimum value of one at the lowest competency level and increased successively to a maximum value of 12 at the highest competency level. All scores subsequently were summed and averaged for comparison.

Web-Page Development and Support

The faculty advisory panel stressed the need to anticipate and minimize negative preconceptions that participation in an assessment would interfere with normal clinical duties and patient care. Questions arising from the advisory panel concerns included how much time would be required to complete a survey, how would confidentiality of the students be protected, and how would the completed self-assessment rubric be returned and handled without risk of accidental breech of confidentiality?

Disruption of normal duties and service operations had to be avoided however possible. This requirement was best satisfied by designing a process that integrated the self-assessment instrument into the “clinical service rhythm” in a way that neither clinicians nor students were required to reassign patient care or diagnostic services to a secondary priority falling behind completion of the instrument.

The selected method made use of desktop computer workstations conveniently located in every clinical service area throughout the Small Animal Clinic and VMTH.

Posting the self-assessment rubric as a Web-page enabled students to easily access the instrument in an asynchronous manner on a 24-hour basis without leaving the service area or distancing themselves from their assigned patient animals. Once the rubric had been accessed, the student could remain on-line for as long as desired, or save their responses and exit as many times as necessary before completing the instrument.

Web-page development and maintenance was contracted through the Texas A&M University Measurement and Research Services (MARS) with personal consultation and assistance from Mark E. Troy, PhD, Associate Director. Program features of the Web-page provided the primary security and confidentiality assurances that were recommended by the faculty advisory group. Secondary assurances for student confidentiality were the product of institutional autonomy separating the CVM-BS and MARS, making it highly unlikely that a student would be recognized by others outside the college. Designed from the outset to be a blind study, student identities and self-assessment responses were not visible or accessible to either the principal investigator or the faculty clinician responsible for providing a comparison assessment of the student. Scores generated from the completed assessments were data-based by the program and stored until needed for statistical analysis at the termination of the survey. Included in the data base were narrative comments from the respondents (students and faculty clinician) and optional information describing the demographics of the veterinary students participating in the survey.

Data Collection Process

The Clinical Competency Assessment Rubric; Problem-Solving Skill was developed by the principal investigator of the research study. Input for development of the instrument was provided by the five-member panel of expert clinical faculty advisors. The faculty offered important contribution to the design of the rubric including focus of content, clarity, and competency descriptors.

Fee based technical services and expertise in the development and maintenance of the Web-page were contracted with MARS. Technical services included scripting and formatting of the Web-page, development and maintenance of the Web-page content, data-basing of the student responses, and formatting of the descriptive statistics.

Incoming fourth-year veterinary medical students, graduating class of 2008, were the targeted population for assessment of problem-solving clinical competency skill. Selection requirements and criteria were described at the beginning of this chapter.

Notification of Respondents

All third-year students identified by the Office of the Dean, CVM-BS, as having been accepted into the graduating class of 2008, were addressed in person approximately 10 days prior to the start of the academic year that began in May, 2007,

and informed of the planned assessment. Students were provided information about the assessment objectives and participation requirements, and were given written statements verifying informed consent prior to participation in the research. Only those students who signed and returned an informed consent form were accepted and included as a member of the sample (n = 59) eligible to participate.

A personalized "thank you" letter to reinforce appreciation for voluntary participation in the project was composed and sent to every student who returned a signed informed consent form. The secondary focus of the letter addressed future communications and provided students with the principal investigator's contact information including telephone numbers and personal e-mail address. Subsequent communications with students involved e-mails and personal conversations.

A strategy was developed and standardized to enhance the student response reliability on both the pre- and post-clinical self-assessments, and to ensure that both assessments were completed by all who volunteered to participate. The procedure was repeated for every clinical rotation identified for sampling. The week preceding the start of a clinical rotation (every rotation begins on Monday) was marked to initiate an e-mail to every student identified to complete a self-assessment during the upcoming rotation. The content was the same for every e-mail transmitted with the exception of date-specific information about start and end times for taking the survey.

The e-mail opened with a salutation to thank the students for participating in the self-assessment and advising them of the potential value to be gleaned by the information to be provided. The primary content was directed at providing advance familiarity with the format of the Web-page and the rubric they would be using in their assessment. Information provided to the students included an overview of the intent of the rubric, guidance for making relative comparisons between themselves and other veterinary students, and a list of the 12 major performance measures with short notes to assist with recognizing hypothetical relationships between performance measures and performance tasks. Supplemental information included advice about software limitations that hindered the changing of answers, instructions of how to make answer changes, and closing information that included an invitation to contact the principal investigator if questions or needs for additional information arose.

Student Self-Assessment

In addition to the e-mail sent by the principal investigator, a second e-mail containing instruction for logging onto the self-assessment Web page was composed and transmitted to each student individually. The e-mail instruction normally was sent by noon Friday of the weekend leading into the start of the clinical rotation. Students could log onto the Web-page anytime that was convenient to them after receipt of instruction. The pre-clinical self-assessment was available to students over a four-day period, starting the weekend preceding the beginning of the clinical rotation and extending through the first two days of the rotation.

Students self-assessed and scored their perceived competency level based on the descriptive information contained within each performance task cell. The construction of clear and distinctive performance task descriptions was an important component of the instrument. Especially important was the need to eliminate ambiguity and clearly define distinctive acts or actions that identified end points and created separation between competency levels. Competency level labeling was designed to remove similarity, eliminate ambiguity, and clearly distinguish the differences between each level.

Each competency level was assigned a numeric score range scaled in increments of three units per level. This scale established in-turn the score range applicable to the performance tasks between each corresponding competency level. For example, the lowest range allowed a possible score of one to three for a “Less Than Minimally Competent Student” compared to the maximum score of 10-12 for “Among The Most Competent Students.” Students were asked to choose the performance task descriptions that best matched their perceived performance and then assign a score from within the numeric range that best quantified their self-assessment for that competency level. Scores could be controlled within the three-point range of the corresponding competency level but could not be reduced or increased outside the range of the level selected. Narrative comments could be added for each performance task if desired. All performance tasks, total 43, were required to be scored before the instrument could be submitted and the assessment considered complete. This process was repeated at the end of the two-week clinical rotation to provide the comparison post-clinical self-assessment.

Faculty Clinician Assessment

The student post-clinical self-assessment was paired with a faculty clinical instructor assessment of the student’s problem solving skills at the end of the two week clinical rotation. The same faculty clinician assessed all students in the sample group (n = 26) using the same rubric and Web-page format. A prime objective of the faculty assessment was to assist with establishing intra-rater reliability of the instrument. The research design did not include a paired pre-clinical assessment by the faculty clinician.

Analysis of Data

The data were analyzed using R v2.6.1 for Windows. The data are reported as descriptive statistics, including a *t*-test for repeated measures, a Pearson product-moment correlation coefficient (*r*) to determine the relationship between the student's post-clinical self-assessment and the clinician's post-clinical assessment, and an effect size index, Cohen *d*. Additionally, a coefficient of determination, r^2, was calculated to reflect the proportion of common variance affecting the two measurements. Analysis of data is presented in Chapter IV.

CHAPTER IV

RESEARCH FINDINGS AND DISCUSSION

Describing Clinical Competency

This study sought to answer the research question; does a relationship exist between clinical competency and student practicum experience with live-patient animals? What evidence exists and can it be measured? Veterinary colleges across the United States, and some foreign countries, are struggling with increasing social and animal rights activist objections to using live animals in the professional education programs. Opponents of live-animal instruction claim that the quality of education is just as high, and equally effective, using alternative learning experiences including cadaver models, virtual simulation, and patient mannequins. Almost all veterinary colleges have investigated ways to replace live animal instruction with simulation models in as many courses as possible (Mangan, 2000). The College of Veterinary Medicine and Biomedical Sciences (CVM-BS) at Texas A&M University, a recognized leader in veterinary medical education and research, has maintained live animal instruction in the professional curriculum throughout its institutional history, and continues today to maximize instruction using live animals through the integration of veterinary student clinical instruction with the service component of veterinary patient care in the Veterinary Medical Teaching Hospital.

The purpose for this study identified two primary objectives underpinned by six specified research objectives. The two primary objectives identified (a) the need to define clinical competency for veterinary medical students approaching graduation, and (b) construct a rubric to measure and assess the level of clinical competency demonstrated by fourth-year veterinary students prior to entry into professional practice, and qualify variables affecting learning and development of AVMA mandated skills.

The development of a definition for clinical competency was considered a necessary precursor to the design of the rubric. The accuracy and reliability of the rubric would be dependent in large part upon the descriptors identifying knowledge and behaviors commonly agreed upon and accepted within the veterinary medical profession.

The entire process of this study required integration with, and participation by the principal stakeholders in the College of Veterinary Medicine and Biomedical Sciences, specifically the fourth-year students, participating faculty, and the executive officers within their lines of authority. The development of the first two specified research objectives, (a) receive approval and buy-in of the Office of the Dean, College of Veterinary Medicine and Biomedical Sciences, and academic department heads, and (b) establish a five-member, clinical expert, faculty advisory panel as consultants about professional veterinary medicine and clinical competency, were identified as the steps required to secure stakeholder buy-in to the study.

The first research objective was achieved following discussions and briefing of the executive officers of the CVM-BS. The purpose of the study was described as a contributing component in the college effort to document compliance with requirements for AVMA accreditation of the professional curriculum.

The second research objective, establishment of a five-member panel of expert clinical faculty advisors, was completed in the preparatory phase of the study prior to any attempt to contact students or other faculty directly. The role of the panel was to provide advice and guidance in describing clinical competency for fourth-year veterinary students in residence at Texas A&M University, and to advise on the acceptability of the rubric design.

Each panel member was personally asked to serve as an advisor to the study. Consideration was given to selected factors that were used to describe the strength in professional service experience that the individual carried into the study. The factors included, (a) the clinician's academic rank, (b) the number of years in practice of clinical veterinary medicine, (c) the holding of board specialization diplomate status within a particular discipline, (d) the length of full-time appointment in the academic department, and (e) prior experience in a non-academic clinical practice. Additional factors of equal importance, but more personal in nature, were (a) the feeling of personal and professional respect held for the individual, (b) the strength of confidence in the individual's opinions, (c) the shared experience of having worked together on a wide spectrum of topics and issues through the years, and (d) strength in confidence that feedback on any subject would be candid and well thought out. The variation in the list of considerations was intentionally made broad to maximize the range of personal and professional philosophies, to glean the most of clinical practice experience, and to reach deep into the reservoir of academic experience at Texas A&M University. In addition to the professional strengths and experiences were the life experiences that each member contributed to the study. Each panel member added value in the forms of prior military service, extensive research experience, undergraduate and veterinary medical education from different professional programs across the United States and countries abroad, and personal interests extending into preferences for animal species, breeds, and behavior.

Although this study was not designed as a qualitative research effort, facets of the investigation involved personal interviews and occasional questioning of panel members to clarify points of discussion. Attention to research convention for confidentiality and protection of subject identity was followed by coding individual responses in the conduct of interviews and reporting of results.

Obtaining a definition for competency that satisfies the personal concepts of the majority is considered a task not easily accomplished. While most definitions include an assembly of commonly accepted descriptors suitable for general application, enthusiasm tends to wane whenever a definition is considered for adoption by a specific discipline. General descriptions of competency include key words such as cognition, skills, and behavior qualified by language expressing the capability to demonstrate acts or actions that are appropriate to particular situations (Trent, 2002). Trent elaborates further by adding that competence describes maximal effort such as would be encountered in a testing, artificially constructed environment.

The faculty panel was asked to provide their input to describe clinical competency for veterinary medical students enrolled in the final year (the practicum experience). They were asked to consider the question in the context of the institutional culture and educational objectives of the academic department, Small Animal Clinical Sciences. The contextual qualification was considered to be an important discriminator. With more than thirty years experience in veterinary clinical management, the principal investigator has observed, and anecdotally has received opinions, that the culture of veterinary medicine tends to polarize along interests associated with different animal species, and that clear differences in practice philosophy, expectations of knowledge and abilities, and differences in professional values are sometimes manifested between small animal, large animal, or mixed animal practice clinicians. While no value is assigned for differences, neither should a value be assumed by the reader equating differences with higher professional standards or improved quality of care. The researcher considers it prudent to acknowledge that the discussion point exists and should be accounted for in framing the range of inference that could be made when reading a definition arrived at by a panel of small animal clinicians. It was not within the scope of this study to classify or otherwise quantify professional cultural differences, however, it was intended that the reference for a definition of clinical competency be identified as originating in, and having relevance only to, the Department of Small Animal Clinical Sciences.

The request for a description of clinical competency received four responses from the individual members of the panel. While no two responses used exact wording or descriptions, they collectively communicated very similar themes expressing the process and expectation of outcomes in student behavior relative to clinical competency.

A theme common to all respondents was based on situational problem solving; a task that sometimes involves creating an accurate rule-out list and differentiating between possible causes and effects. Each clinical case brings its own history and set of circumstances, along with external variables that have potential for student success or disappointment. Situational awareness exists as a constant throughout the process of problem resolution and diagnosis.

The second theme emphasized student ability. The ability to discuss, the ability to communicate the logic used when formulating a decision or action, the ability to act upon decisions and rationally defend actions or conclusions about the problem, and the ability to functionally apply knowledge and skill across a broad spectrum of conditions.

The third theme was the limitation, stated and implied, that the situation was assumed to be descriptive of a primary care patient. The researcher regarded the limitation of the primary care patient to be the standard for assessment purposes in describing the expectations for a student's skill level and role responsibility in patient management. Although, it was understood that students overall are routinely involved with, and challenged by, diagnostics and case responsibilities of higher degrees throughout their fourth-year experience.

The responses of the expert panel did not produce a concise, absolute description of competency recognized as a standard for veterinary medicine by everyone; that was neither the intent of the request nor was it an expectation of anyone considering the question. What was produced, however, were carefully thought out descriptions of the need for knowledge, the need for skills, the need for abilities, the need for logic, and reasoning to support critical analysis and decision making every time a veterinary student or practicing veterinarian interacts with a patient. These same elements and conditions were similarly stated by Dooley and Lindner writing that competencies "establish the behavior requirements needed to be successful as a student" (2002, p. 25) and that competencies are related by knowledge, skills, and abilities.

Clearly visible within each panel member response was the same description of articles based in the domains for cognition, knowledge, and skills that have been listed as core components of competency in the literature. The collective descriptions served as principal material to reinforce the theoretical base supporting the rubric design.

Drawing upon the themes generated by the faculty panel, and with consideration of the descriptions of competency found in the theoretical literature, the researcher restated competency to be, the ability to perform tasks, or respond with appropriate behavior, to produce a desired effect in conditions or situations.

A Partial Profile of Veterinary Student Participants

An implicit goal from the beginning of this study has been to present the most complete and accurate measurement of veterinary student competency that the design would allow. Within that context, the research design was expanded slightly to include an optional section in the Web page that contained a very limited set of demographic questions. It was felt that information of this type may be helpful in identifying areas of interest for future research, and it may provide information or ideas helpful to recruitment, selection, or curriculum committees in the CVM-BS. A second reason for collecting the individual demographics was the desire to support the assumption that the student sample was representative of the population of veterinary medical students. The variables of age at the time of admission to the program, prior education and advanced degrees held, and prior work experience are demographics that can be compared with open records demographics collected by the CVM-BS. Students were encouraged to complete the survey questions but were not obligated in any way, and no information affected the final statistical analysis of data.

The questions were limited to simple description of the students’ experience and education. The intention for the questions was to help the reader, as well as researcher, search for or recognize possible associations between life experience and decision making.

The selection criteria for admission into the professional program do not discriminate against or pre-select for undergraduate education or prior life experience (i.e. there is no admission requirement that an applicant must have prior work experience in a veterinary clinic). Because there is no prescribed common background, assumptions should be made cautiously about student problem-solving ability. The scope of life experiences of students who have been admitted to veterinary school are known to have included lawyers, military aviators, nuclear engineer submariners (a rated petty officer), agricultural extension county agents, a high school music teacher, police officers, registered nurses, and a U. S. Army sniper. At least an equal number of students have also been admitted with life experience limited to part-time employment while completing undergraduate course work. Faculty has also commented that they have observed an increasing number of students, and veterinary college applicants, who have made a life-decision to selected veterinary medicine as their second career.

Information obtained from the Office of the Dean, CVM-BS, relates that the average age of a student is 25 years old upon entry into the professional curriculum. Although this study intentionally did not include gender in the survey as a security precaution against accidental disclosure of student identity, it can safely be stated that the professional curriculum is predominantly female, representing approximately 60-70% of the student body (CVM, 2008). At least half of the students have completed a four year undergraduate degree at the time of admission, and the average applicant will apply at least twice before being granted admission.

The list of questions included (a) age, within a range of four years, (b) prior academic degrees, (c) identification of post-graduation career track, (d) identification if the student held employment in veterinary medicine prior to admission to veterinary school, (e) identification if the student held leadership positions while employed prior to admission to veterinary school, and (f) identification of the length of time that the student held positions of responsibility prior to admission to veterinary school.

Not every student chose to complete this portion of the survey. Overall, 26 of 31 students did elect to provide the supplemental demographics.

Age Distribution

Information about the age of a student was intentionally limited to a range of four years. This limitation was designed as a precaution against accidental disclosure of student identity as a result of association between age and other demographic information.

The distribution of ages among responding students identified 14 (53.8%) in the 21-25 years old age group, seven (26.9%) in the 26-30 years old age group, four (15.3%) in the 31-35 years old age group, and one (4.0%) who was older than 45 years in age.

Academic Degrees

Students were asked if they possessed an advanced academic degree at the time of admission to veterinary school. Student responses included 22 (84.6%) No, and four (15.3%) Yes, Masters degree.

Career Tracks

Students were asked to identify their declared career track plans. Responses included 12 (46.1%) declared small animal track, five (19.2%) declared large animal track, seven (26.9%) declared mixed animal practice, one (3.8%) declared industry track, and one (3.8%) declared academic track.

Veterinary Medical Experience

The responses to the question whether students had veterinary medical work experience prior to admission to veterinary school included 24 (92.3%) Yes, and two (7.6%) No.

Leadership Experience

Students were asked if they held positions assigning them leadership responsibility and experience in a full-time job prior to admission to veterinary school. Reponses included 13 (50.0%) Yes, and 13 (50.0%) No.

Duration of Prior Leadership Experience

Students were given a follow-on question asking for the approximate length of time that they may have held full-time job leadership responsibility. The responses included three (23.0%) having less than one year duration, five (38.4%) having more than one year but less than three years duration, and five (38.4%) having more than three years duration.

Student Self-Assessment Rubric

The rubric directly addressed research question number three; does a relationship exist between clinical competency and direct student interaction with patient animals? What evidence exists and how can it best be measured? Problem-solving skill was identified as the independent variable and determinant of evidence that clinical competency was achieved during the student's clinical rotation. The rubric enabled the student to self-assess and score her/his perceived level of competency upon entry into the clinical rotation, and repeat the measure as a post-clinical assessment at the conclusion of the rotation. Comparisons between the pre-clinical and post-clinical assessments were made to measure the change.

Students were asked to self-assess their problem solving skills by comparing their perceived skill level to descriptive qualifiers identified specifically for this purpose. The rubric and self-assessment scoring were described previously in Chapter III, Instrumentation, and Student Self-Assessment. The rubric required the students to select the narrative description that best fit their perceived level of competency and assign a score to quantify the strength of skill for the identified task. The 12-point scale was anchored between “Minimally Competent Student” (1) and “Among The Most Competent Students” (12). Scores increased incrementally within a range of three points as the measure ascended across each competency level. Competency levels were described by 12 Performance Measures, under pinned by 43 Performance Tasks (factors) identifying a task, skill, or behavior characteristic. The descriptive statistics reflect the distribution of scores and differences in the means of the 43 Performance Tasks (factors).

The initial estimate of students eligible to participate, those having provided informed consent and who satisfactorily completed the General Surgery clinical service rotation totaled $n = 31$. However, the final count of completed surveys revealed that one student did not complete the self-assessment for either the pre-clinical assessment or the post-clinical assessment as originally anticipated. Another student’s data were not entered for the pre-clinical assessment only. The final tally for student pre-clinical assessments totaled $n = 29$. The post-clinical assessment data reflected similar losses for four students resulting in $n = 27$. The combined data loss total of pre-post clinical assessments was five, resulting in an adjusted paired sample size $n = 26$. The faculty evaluator completed post-clinical assessments and successfully submitted data for all students resulting in $n = 31$, however, that number was adjusted to $n = 26$ following the removal of the five unpaired student assessments.

The lost data were not accounted for until the end of the research period primarily because the research design required the principal investigator and all associated CVM-BS faculty to remain blind to student input.

Student Pre- & Post-Clinical Self-Assessment and Faculty Post-Clinical Assessment

The assessment of problem-solving skill was made by assessing 12 performance measures that contained descriptors of performance tasks. The measurement results, reported as descriptive statistics means and standard deviation, are listed under the sub-headings for performance measures.

This section addresses research objectives four, five, and six for the student pre-clinical and post-clinical self-assessment, followed by the comparison statistics for the faculty post-clinical assessment. Research objective four reports the results of the *t*-test to determine if a significant difference exists between the means of the paired assessments. Research objective five reports the results of a Pearson product-moment correlation coefficient (r) to establish evidence that a relationship exists between live-animal patient care and an increase in clinical competence. Lastly, research objective six reports the results of Cohen *d* as a measure of the effect size index, and a coefficient of determination (r^2) as a measure of the proportion of common variance between the paired assessments. The results are reported for both sets of paired assessments under each sub-heading (12 total) describing the performance measures and the overall perception of the level of competence.

Certain statistics possess negative integers. The negative sign reflects reverse scoring between the pre-clinical assessments minus the post-clinical assessment, indicating an increase in the score. The negative sign is a directional indicator of the calculation and is not indicating a value less than zero.

In some instances the narrative description of the quantified score includes a qualification such as “lower-lower or “lower-upper” range. The first descriptor “lower” refers to the whole number score, i.e 7.0, at the lowest end of the scale in the skill level for a “Fully Competent Student”. The second descriptor, “upper,” refers to the second-tier of the quantified score within the competency skill level , i.e. 7. 9, describing a “Fully Competent Student” who is closer to the middle of the skill level (8.0 being the middle of the range). The use of terminology “lower,” “middle,” and “upper” was intended to aid the reader distinguish discrete variation in the range between whole numbers. The “lower” to “upper” limits were delineated as, Lower range = 0.00- 0.30, Mid range = 0.31- 0.61, Upper range = 0.62 – 0.99.

Initial Assessment

Initial assessment represents the starting point of the veterinary student’s contact and interaction with the patient. It is at this time that the student begins the process of collecting information and assembling facts through direct physical examination of the animal supplemented in detail by answers to questions directed to the animal owner to ascertain what the owner identifies as the primary complaint generating the need for veterinary medical intervention. This assessment measured four performance tasks, including (a) Obtain A Oral History, (b) Examination, (c) Records taking, and (d) Accuracy in collection of facts and describing conditions. The pre-clinical self-assessment was ranked overall as being in the third competency level describing the “Fully Competent Student” for each of the four performance tasks. The post-clinical self-assessment maintained the ranking, although performance mean scores did reflect an increased mean score moving from the lower range to the mid-range for the competency (Lower = 7.0, Middle = 8.0, Upper = 9.0). The performance task means for the Initial Assessment are shown in Table 2.

Table 2

Initial Assessment: Performance Task Means

	Student Pre-Assessment (n = 26)		Student Post-Assessment (n = 26)	
Performance Task	*M*	*SD*	*M*	*SD*
Obtain Oral History	7.48	1.57	8.61	1.26
Examination	7.13	1.50	8.34	1.32
Records	7.75	1.37	8.42	1.23
Accuracy	8.03	1.32	8.61	1.13

The critical *t* value (t = 2.060, df = 25, $p < .05$) was determined from tables (Spatz, 2001). Two performance tasks exceeded the critical *t* value, Obtain A Oral History (t = 4.308), and Examination (t = 4.648) and were determined to be significant at $p < .05$.

A Pearson product-moment correlation coefficient, *r*, value was determined from tables (Spatz, 2001) for the student pre- and post-clinical self-assessment ($r = .38$, $df = 25$, $p < .05$). The performance tasks, Obtain Oral History ($r = 0.59$) and Examination ($r = 0.63$), exceeded the critical value and were determined to have been significant at $p < .05$.

The effect size index, Cohen *d*, for the difference in the means was calculated for each performance task. The accepted index (Spatz, 2001) groups the measures as Small effect = .20, Medium effect = .50, and Large effect d = .80. The effect size for statistically significant performance tasks include Obtain Oral History ($d = 0.79$), and Examination ($d = 0.85$). Overall, the post-clinical assessment scores reflected an increase over the pre-clinical assessment scores.

The coefficient of determination, r^2, was calculated as an indicator of common variance between the two measurements. The percent of common variance between the two measures included Obtained Oral History ($r^2 = 0.35$), and Examination ($r^2 = 0.40$).

The faculty clinician provided direct instruction and mentorship to students during the two week clinical rotation. Both the faculty post-clinical assessment and the student post-clinical assessment ranked overall performance consistent with the third competency level describing the “Fully Competent Student” for each of the four tasks. The mean score of the faculty post-clinical assessment was greater than the mean score of the student post-clinical assessment in each of the four tasks. The performance task means for the Initial Assessment: Faculty Post-Clinical Assessment are shown in Table 3.

Table 3

Initial Assessment: Faculty Post-Clinical Assessment

	Faculty Post-Assessment (n = 26)		Student Post-Assessment (n = 26)	
Performance Task	*M*	*SD*	*M*	*SD*
Obtain Oral History	8.77	1.47	8.61	1.26
Examination	8.74	1.48	8.34	1.32
Records	9.35	1.47	8.42	1.23
Accuracy	9.41	1.40	8.61	1.13

The critical t value (t = 2.060, df = 25, $p < .05$) was determined from tables (Spatz, 2001). One performance task, Accuracy (t = 2.478) exceeded the critical t value and was statistically significant at $p < .05$.

An r value was determined from tables (Spatz, 2001) for the faculty post-clinical and student post-clinical self-assessment (r = .38, df = 25, $p < .05$). No performance task met or exceeded the critical r value or was statistically significant at $p < .05$.

The effect size index, Cohen d, for the difference in the means was calculated for each performance task. The accepted index (Spatz, 2001) groups the measures as

Small effect = .20, Medium effect = .50, and Large effect = .80. Three tasks met or exceeded the value for Small effect. The performance tasks were Examination (*d* = 0.28), Records (*d* = 0.68), and Accuracy (*d* = 0.62).

The coefficient of determination, r^2, was calculated as an indicator of common variance between the two measurements. No performance task exceeded $r^2 = .04$.

Knowledge

This performance measure assessed the student's sources of knowledge ranging from life experience and prior education to application of knowledge within the context of the clinical problem. The measure was described by four performance tasks, including, (a) Prior Learning, (b) Self-Directed Learning, (c) Mastery of Concepts, and (d) Application (of knowledge). The pre-clinical self-assessment was ranked overall as being in the third competency level describing the "Fully Competent Student" for each of the four performance tasks. The post-clinical self-assessment maintained the ranking, although performance mean scores did reflect an increased mean score extending from the middle range ($M = 8.61$) to the upper-lower range ($M = 9.23$) for the competency. The performance task means for Knowledge are shown in Table 4.

Table 4

Knowledge: Performance Task Means

	Student Pre-Assessment (n = 26)		Student Post-Assessment (n = 26)	
Performance Task	*M*	*SD*	*M*	*SD*
Prior Learning	7.62	1.63	8.61	1.41
Self-Directed Learn…	8.20	1.11	9.11	1.10
Mastery of Concepts	7.79	1.37	8.92	1.46
Application	8.31	1.40	9.23	1.33

All four performance tasks exceeded the critical t value (t = 2.060, df = 25, $p < .05$), including Prior Learning (t = 2.820), Self-Directed Learning (t = 3.867), Mastery of Concepts (t = 3.071), and Application (t = 3.764). Each was determined to be significant at $p < .05$.

An r value was determined from tables (Spatz, 2001) for the student pre- and post-clinical self-assessment (r = .38, df = 25, $p < .05$). The performance tasks, Prior Learning (r = 0.4717), Self-Directed Learning (r = 0.41), Mastery of Concepts (r = 0.38) and Application ($r = 0.64$) exceeded the critical value and were determined to have been significant at $p < .05$.

The effect size index, Cohen *d*, for the difference in the means was calculated for each performance task. The accepted index (Spatz, 2001) groups the measures as Small effect = .20, Medium effect = .50, and Large effect = .80. The effect size for statistically significant performance tasks include Prior Learning ($d = 0.65$), Self-Directed Learning ($d = 0.81$), Mastery of Concepts ($d = 0.79$), and Application ($d = 0.65$). Overall, the post-clinical assessment scores reflected an increase over the pre-clinical assessment scores.

The coefficient of determination, r^2, was calculated as an indicator of common variance between the two measurements. The percent of common variance included Prior Learning ($r^2 = 0.22$), Self-Directed Learning ($r^2 = 0.17$), Mastery of Concepts ($r^2 =0.14$), and Application ($r^2 = 0.41$).

Both the faculty post-clinical assessment and the student post-clinical assessment ranked overall performance consistent with the third competency level describing the “Fully Competent Student” for each of the four tasks. The mean score of the faculty post-clinical assessment in one task, Prior Learning, was greater than the mean score of the student post-clinical assessment. The performance task means for Knowledge: Faculty Post-Clinical Assessment are shown in Table 5.

Table 5

Knowledge: Faculty Post-Clinical Assessment

	Faculty Post-Assessment (*n* = 26)		Student Post-Assessment (*n* = 26)	
Performance Task	*M*	*SD*	*M*	*SD*
Prior Learning	8.87	1.85	8.61	1.41
Self-Directed Learn…	9.12	1.72	9.11	1.10
Mastery of Concepts	8.64	1.81	8.92	1.46
Application	8.70	1.65	9.23	1.33

The critical *t* value ($t = 2.060$, $df = 25$, $p < .05$) was determined from tables (Spatz, 2001). No performance task exceeded the critical *t* value, or was found statistically significant a $p < .05$.

An *r* value was determined from tables (Spatz, 2001) for the faculty post-clinical and student post-clinical self-assessment ($r = .38$, $df = 25$, $p < .05$). No performance task met or exceeded the critical *r* value or was found statistically significant at $p < .05$.

The effect size index, Cohen *d*, for the difference in the means was calculated for each performance task. The accepted index (Spatz, 2001) groups the measures as

Small effect = .20, Medium effect = .50, and Large effect = .80. The effect sizes were calculated for all measures. One task, Application (d = 0.34), exceeded the value for Small effect.

The coefficient of determination, r^2, was calculated as an indicator of common variance between the two measurements. No performance task exceeded r^2 = 0.11.

Analyze Data

This performance measure asked the student to look at data from a broad perspective and consider the interrelationships, account for the variables affecting the situation, to explore emerging patterns, and to organize and compare preliminary results. Three performance tasks were assessed in this measure including, (a) Recognizes Interrelationships, (b) Recognizes Trends, and (c) Validates Data. The pre-clinical self-assessment was ranked overall as being in the third competency level describing the "Fully Competent Student" for each of the three performance tasks. The post-clinical self-assessment maintained the ranking, although performance mean scores did reflect an increased mean score extending from the middle range (M = 8.57) to the middle-upper range (M = 8.88) for the competency. The performance task means for Analyze Data are shown in Table 6.

Table 6

Analyze Data: Performance Task Means

	Student Pre-Assessment (n = 26)		Student Post-Assessment (n = 26)	
Performance Task	*M*	*SD*	*M*	*SD*
Recognizes Inter…	7.72	1.33	8.57	1.17
Recognizes Trends	8.06	1.31	8.88	1.17
Validates Data	7.86	1.21	8.80	1.47

Two performance tasks exceeded the critical t value (t = 2.060, df = 25, $p < .05$), including Recognizes Interrelationships (t = 2.295), and Validates Data (t = 3.570). Each was determined to be significant at $p < .05$.

An r value was determined from tables (Spatz, 2001) for the student pre- and post-clinical self-assessment (r = .38, df = 25, $p < .05$). The performance tasks, Validates Data (r = 0.56) exceeded the critical value and was determined to have been significant at $p < .05$.

The effect size index, Cohen d, for the difference in the means was calculated for each performance task. The accepted index (Spatz, 2001) groups the measures as Small

effect = .20, Medium effect = .50, and Large effect = .80. The effect sizes were calculated for all performance tasks and are reported for all meeting or exceeding the value for a Small effect, including Recognizes Interrelationships (d = 0.67), Recognizes Trends (d = 0.65), and Validates Data (d = 0.70). Overall, the post-assessment scores reflected an increase over the pre-assessment scores.

The coefficient of determination, r^2, was calculated as an indicator of common variance between the two measurements. The percent of common variance between the two measures included Recognizes Interrelationships ($r^2 = 0.67$), Recognizes Trends ($r^2 = 0.00$), and Validates Data ($r^2 = 0.31$).

Both the faculty post-clinical assessment, and the student post-clinical assessment, ranked overall performance consistent with the third competency level describing the “Fully Competent Student” for each of the three tasks. The mean score of the faculty post-clinical assessment was less than the mean score of the student post-clinical assessment in each performance task. The performance task means for Analyze Data: Faculty Post-Clinical Assessment are shown in Table 7.

Table 7

Analyze Data: Faculty Post-Clinical Assessment

	Faculty Post-Assessment (n = 26)		Student Post-Assessment (n = 26)	
Performance Task	*M*	*SD*	*M*	*SD*
Recognizes Inter…	8.12	1.31	8.57	1.17
Recognizes Trends	8.67	1.24	8.88	1.17
Validates Data	8.61	1.33	8.80	1.47

The critical t value (t = 2.060, df = 25, p < .05) was determined from tables (Spatz, 2001). No performance task met or exceeded the critical t value or was found statistically significant at p < .05.

An r value was determined from tables (Spatz, 2001) for the student post-clinical and faculty post-clinical self-assessment (r = .38, df = 25, p < .05). No performance task met or exceeded the critical "r" value or was found statistically significant at p < .05.

The effect size index, Cohen d, for the difference in the means was calculated for each performance task. The accepted index (Spatz, 2001) groups the measures as

Small effect = .20, Medium effect = .50, and Large effect d = .80. Although no statistically significant performance tasks were reported, the effect sizes were calculated for all measures and are reported for tasks having met or exceeded the value for Small effect. The single performance task to exceed the value for a Small effect was Recognizes Interrelationships (d = 0.36).

The coefficient of determination, r^2, was calculated as an indicator of common variance between the two measurements. No performance task exceeded r^2 = .02 (Validates Data).

Develop Hypothesis

This performance measure required the student to assess their ability to articulate scientific principles involved in the problem, consider how well they have demonstrated deductive thinking or how often they initiate a literature review to search the current status of the problem. The measure also asks the student to assess what kind of questions they pose about the problem and whether they construct test or devise methods to reveal weaknesses in their assumptions and logic. Three performance tasks were contained within this performance measure, including (a) Theoretical Framework, (b) Acquisition of Knowledge, and (c) Plausibility (of Hypothesis). The pre-clinical self-assessment was ranked overall as being in the third competency level describing the "Fully Competent Student" for each of the three performance tasks. The post-clinical self-assessment maintained the ranking, although performance mean scores did reflect an increased mean score extending across the middle to middle-upper range for the competency. The performance task means for Develop Hypothesis are shown in Table 8.

Table 8

Develop Hypothesis: Performance Task Means

	Student Pre Assessment (n = 26)		Student Post Assessment (n = 26)	
Performance Task	*M*	*SD*	*M*	*SD*
Theoretical Frame…	8.10	1.51	8.57	1.39
Acquisition of Kno…	7.79	1.31	8.42	1.50
Plausibility	8.37	1.6 1	8.73	1.21

No performance task exceeded the critical *t* value ($t = 2.060$, $df = 25$, $p < .05$) or was found to have a statistically significant difference between measures.

An *r* value was determined from tables (Spatz, 2001) for the student pre- and post-clinical self-assessment ($r = .38$, $df = 25$, $p < .05$). The performance task, Theoretical Framework ($r = 0.44$), exceeded the critical value and was determined to have been significant at $p < .05$.

The effect size index, Cohen *d*, for the difference in the means was calculated for each performance task. The accepted index (Spatz, 2001) groups the measures as Small effect = .20, Medium effect = .50, and Large effect = .80. The effect sizes were calculated for all performance tasks and are reported for all meeting or exceeding the value for a Small effect, including Theoretical Framework (d = 0.32), Acquisition of Knowledge (d = 0.44), and Plausibility (d = 0.24). Overall, the post-clinical assessment reflected an increase in score over the pre-clinical assessment.

The coefficient of determination, r^2, was calculated as an indicator of common variance between the two measurements. The percent of common variance between the two measures included Theoretical Framework (r^2 = 0.19), Acquisition of Knowledge (r^2 = 0.13), and Plausibility (r^2 =0.05).

Both the faculty post-clinical assessment and the student post-clinical assessment ranked overall performance consistent with the third competency level describing the "Fully Competent Student" for each of the three tasks. The mean score of the faculty post-clinical assessment was greater than the mean score of the student post-clinical assessment in two tasks, Acquisition of Knowledge and Plausibility. The performance task means for Develop Hypothesis: Faculty Post-Clinical Assessment are shown in Table 9.

Table 9

Develop Hypothesis: Faculty Post-Clinical Assessment

	Faculty Post-Assessment (n = 26)		Student Post-Assessment (n = 26)	
Performance Task	*M*	*SD*	*M*	*SD*
Theoretical Frame…	8.00	1.48	8.57	1.39
Acquisition of Kno…	8.80	1.27	8.42	1.50
Plausibility	8.93	1.23	8.73	1.21

The critical *t* value (t = 2.060, df = 25, $p < .05$) was determined from tables (Spatz, 2001). No performance task measurements exceeded the predicted *t* value.

An *r* value was determined from tables (Spatz, 2001) for the student post-clinical self-assessment and faculty post-clinical assessment (r = .38, df = 25, $p < .05$). No performance task measure met or exceeded the critical value or was determined to have been significant at $p < .05$.

The effect size index, Cohen *d*, for the difference in the means was calculated for each performance task. The accepted index (Spatz, 2001) groups the measures as Small effect = .20, Medium effect = .50, and Large effect = .80. The effect sizes were calculated for all performance tasks and are reported for all meeting or exceeding the value for a Small effect, including Theoretical Framework (d = 0.40), and Acquisition of Knowledge (d = 0.27). Overall, the student post-clinical assessment score reflected an increase over the pre-clinical assessment score.

The coefficient of determination, r^2, was calculated as an indicator of common variance between the two measurements. No performance task measure exceeded the value, $r^2 = 0.05$ (Acquisition of Knowledge).

Assessing/ Assigning Risk

This performance measure assessed the student's considerations of risk associated with the treatment of the patient's primary complaint. Examples of risk could be assigned to secondary complications, age, or pre-disposition associated with different breeds of animals. The student was asked to consider their ability to recognize specific activities associated with the risk, recognize predictable secondary outcomes of medications or therapy, and to weigh risk vs benefit outcomes in decision making. Three performance tasks were assessed in this measure, including (a) Assesses the situation, (b) Analyzes the variables affecting the situation, and (c) Estimates Risk vs Benefit outcomes. The pre-clinical self-assessment was ranked overall as being in the third competency level describing the "Fully Competent Student" for each of the three performance tasks. The post-clinical self-assessment maintained the ranking, although performance mean scores did reflect an increased mean score extending from the middle-upper range (M = 8.73) to the upper-lower (M = 9.03) range for the competency. The performance task means for Assessing/Assigning Risk are shown in Table 10.

Table 10

Assessing/Assigning Risk: Performance Task Means

	Student Pre-Assessment (n = 26)		Student Post-Assessment (n = 26)	
Performance Task	*M*	*SD*	*M*	*SD*
Assesses (Risk)	8.06	1.48	8.73	1.25
Analyzes (Risk)	8.10	1.34	8.80	1.16
Est. Risk v Benefit	8.13	1.38	9.03	1.21

Two performance task measurements exceeded the critical t value (t = 2.060, df = 25, p < .05) including Assesses (Risk) (t = 2.335), and Estimates Risk vs Benefit (t = 2.449). Overall, the post-clinical assessment scores reflected an increased over the pre-clinical assessment score.

An *"r"* value was determined from tables (Spatz, 2001) for the student pre- and post-clinical self-assessment (r = .38, df = 25, p < .05). No performance task measure met or exceeded the critical value or was determined to have been significant at p < .05.

The effect size index, Cohen *d*, for the difference in the means was calculated for each performance task. The accepted index (Spatz, 2001) groups the measures as Small effect = .20, Medium effect = .50, and Large effect = .80. The effect sizes were calculated for all performance tasks, and reported for all tasks meeting the value for a Small effect, including Assesses (Risk) (d = 0.48), Analyzes (Risk) (d = 0.55), and Estimates Risk vs Benefit (d = 0.69). Overall, the student post-clinical assessment score reflected an increase over the pre-clinical assessment score.

The coefficient of determination, r^2, was calculated as an indicator of common variance between the two measurements. The percentage of common variance included Assesses (Risk) (r^2 = 0.13), Analyzes (Risk) (r^2 = 0.00), and Plausibility (r^2 = 0.05).

Both the faculty post-clinical assessment and the student post-clinical assessment ranked overall performance consistent with the third competency level describing the "Fully Competent Student" for each of the three tasks. The mean score of the faculty post-clinical assessment was greater than the mean score of the student post-clinical assessment in two tasks, Assesses (Risk) and Analyzes (Risk). The performance task means for Assessing/Assigning Risk; Faculty Post-Clinical Assessment are shown in Table 11.

Table 11

Assessing/Assigning Risk: Faculty Post Clinical Assessment

	Faculty Post Assessment (n = 26)		Student Post Assessment (n = 26)	
Performance Task	*M*	*SD*	*M*	*SD*
Assesses (Risk)	8.90	1.57	8.73	1.25
Analyzes (Risk)	8.83	1.63	8.80	1.16
Est. Risk v Benefit	8.87	1.17	9.03	1.21

The critical t value (t = 2.060, df = 25, p < .05) was determined from tables (Spatz, 2001). No performance task measurement met or exceeded the predicted t value or was found to be significant at p < .05.

An r value was determined from tables (Spatz, 2001) for the student post-clinical self-assessment and faculty post-clinical assessment (r = .38, df = 25, p < .05). No performance task measure met or exceeded the predicted value or was found to have been significant at p < .05.

The effect size index, Cohen d, for the difference in the means was calculated for each performance task. The accepted index (Spatz, 2001) groups the measures as Small

effect = .20, Medium effect = .50, and Large effect = .80. The effect sizes were calculated and reported for all performance tasks meeting the value for a Small effect, including Assesses (Risk) (d = 0.12), Analyzes (Risk) (d = 0.02), and Estimates Risk vs Benefit (d = 0.14). Overall, the student post-clinical assessment score reflected an increase over the pre-clinical assessment score.

The coefficient of determination, r^2, was calculated as an indicator of common variance between the two measurements. The percentage of common variance included Assesses (Risk) (r^2 = 0.03), Analyzes (Risk) (r^2 = 0.02), and Estimates Risk vs Benefit (r^2 = 0.00).

Making Decisions

The student self-assessed their ability in making decisions about the problem and intended courses of action to address the problem. Assessment was made of the accuracy demonstrated in analyzing the problem and possible underlying causes, the ability to retain accuracy in their analysis as problems became more complex, and for the ability to make choices when presented with multiple courses of action requiring development of alternate plans. Four performance tasks were assessed in this performance measure, including (a) Organizes Facts, (b) Recognizes Secondary Outcomes, (c) Seeks & Gives Input, and (d) Retains Objectivity. The pre-clinical self-assessment was ranked overall as being in the third competency level describing the “Fully Competent Student” for each of the four performance tasks. The post-clinical self-assessment maintained the ranking, although performance mean scores did reflect an increased mean score extending from the middle range (M = 8.53) to the upper range

(*M* = 9.0) for the competency. The performance task means for Making Decisions are shown in Table 12.

Table 12

Making Decisions: Performance Task Means

	Student Pre-Assessment (*n* = 26)		Student Post-Assessment (*n* = 26)	
Performance Task	*M*	*SD*	*M*	*SD*
Organizes Facts	8.00	1.43	8.61	1.26
Recog. Secondary…	7.75	1.18	8.76	1.24
Seeks & Gives Input	8.48	1.47	9.00	1.67
Retains Objectivity	7.65	1.56	8.53	1.39

Three performance task measurement met or exceeded the critical *t* value ($t = 2.060$, $df = 25$, $p < .05$), including Organizes Facts ($t = 2.222$), Recognizes Secondary Outcomes ($t = 3.764$), and Retains Objectivity ($t = 2.670$). Each task was found statistically significant at $p < .05$. Overall, the student post-clinical assessment score reflected an increase over the pre-clinical assessment score.

An "*r*" value was determined from tables (Spatz, 2001) for the student pre- and post-clinical self-assessment ($r = .38$, $df = 25$, $p < .05$). Three performance task measures met or exceeded the critical value and were determined to have been significant at $p < .05$, including Organizes Facts ($r = 0.43$), Recognizes Secondary Outcomes ($r = 0.50$), and Retains Objectivity ($r = 0.40$).

The effect size index, Cohen *d*, for the difference in the means was calculated for each performance task. The accepted index (Spatz, 2001) groups the measures as Small effect = .20, Medium effect = .50, and Large effect = .80. The effect sizes were calculated and reported for all performance tasks meeting the value for a Small effect, including Organizes Facts ($d = 0.45$), Recognizes Secondary Outcomes ($d = 0.83$), Seeks & Gives Input ($d = 0.32$), and Retains Objectivity ($d = 0.59$). Overall, the student post-clinical self-assessment score reflected an increase over the pre-clinical assessment score.

The coefficient of determination, r^2, was calculated as an indicator of common variance between the two measurements. The percentage of common variance included Organizes Facts ($r^2 = 0.18$), Recognizes Secondary Outcomes ($r^2 = 0.25$), Seeks & Gives Input ($r^2 = 0.10$), and Retains Objectivity ($r^2 = 0.16$).

Both the student post-clinical assessment and the faculty post-clinical assessment ranked overall performance consistent with the third competency level describing the "Fully Competent Student" for each of the four tasks. The mean score of the faculty post-clinical assessment was greater than the mean score of the student post-clinical assessment in one task, Retains Objectivity. The performance task means for Making Decisions; Faculty Post-Clinical Assessment are shown in Table 13.

Table 13

Making Decisions: Faculty Post-Clinical Assessment

	Faculty Post-Assessment (n = 26)		Student Post-Assessment (n = 26)	
Performance Task	*M*	*SD*	*M*	*SD*
Organizes Facts	8.45	1.54	8.61	1.26
Recog. Secondary…	8.51	1.38	8.76	1.24
Seeks & Gives Input	8.87	1.68	9.00	1.67
Retains Objectivity	8.61	1.52	8.53	1.39

No performance task measurement met or exceeded the critical t value ($t = 2.060$, $df = 25$, $p < .05$) or was found statistically significant at $p < .05$.

An "*r*" value was determined from tables (Spatz, 2001) for the student post-clinical self-assessment and faculty post-clinical assessment ($r = .38$, $df = 25$, $p < .05$). No performance task measure met or exceeded the critical value or was found to have been significant at $p < .05$.

The effect size index, Cohen *d*, for the difference in the means was calculated for each performance task. The accepted index (Spatz, 2001) groups the measures as Small effect = .20, Medium effect = .50, and Large effect = .80. The effect sizes were calculated and reported for all performance tasks meeting the value for a Small effect, including Organizes Facts ($d = 0.11$), Recognizes Secondary Outcomes ($d = 0.19$), Seeks & Gives Input ($d = 0.07$), and Retains Objectivity ($d = 0.05$).

The coefficient of determination, r^2, was calculated as an indicator of common variance between the two measurements. The percentage of common variance included Organizes Facts ($r^2 = 0.01$), Recognizes Secondary Outcomes ($r^2 = 0.00$), Seeks & Gives Input ($r^2 = .00$), and Retains Objectivity ($r^2 = 0.06$).

Determining Courses of Action

This performance measure assessed the student's ability to establish a clear recognition of goals or determine expected outcomes. It also included examination of pros vs cons of selecting courses of action and development of plans to mitigate risk or adverse outcomes. The student was asked to assess personal limits in skill, experience, or equipment that had the potential to affect outcomes, and the use of caution when situations dictate. Three performance tasks were assessed in this measure, including (a) Able To State Objectives, (b) Assesses Current Situation, and (c) Assess Capabilities. The pre-clinical self-assessment was ranked overall as being in the third competency level describing the "Fully Competent Student" for each of the three performance tasks. The post-clinical self-assessment maintained the ranking, although performance task mean scores did reflect an increased mean score extending from the middle-upper range

(*M* = 8.73) to the upper-lower range (*M* = 9.07) for the competency. The performance task means for Determining Courses of Action are shown in Table 14.

Table 14

Determining Courses of Action: Performance Task Means

	Student Pre-Assessment (*n* = 26)		Student Post-Assessment (*n* = 26)	
Performance Task	*M*	*SD*	*M*	*SD*
Able To State Obj…	8.24	1.24	8.73	1.18
Assesses Situation	8.34	1.28	8.92	1.12
Assesses Capabilities	8.41	1.15	9.07	1.12

One performance task measurement met or exceeded the critical *t* value ($t = 2.060$, $df = 25$, $p < .05$), Assesses Capabilities ($t = 2.880$) and was found statistically significant at $p < .05$. Overall, the student post-clinical assessment score reflected an increase over the pre-clinical assessment score.

An "*r*" value was determined from tables (Spatz, 2001) for the student pre-clinical self-assessment and post-clinical assessment ($r = .38$, $df = 25$, $p < .05$). One performance task measures met or exceeded the critical value, Assess Capabilities (*r* = 0.39), and was determined to have been significant at $p < .05$.

The effect size index, Cohen *d*, for the difference in the means was calculated for each performance task. The accepted index (Spatz, 2001) groups the measures as Small effect = .20, Medium effect = .50, and Large effect = .80. The effect sizes were calculated and reported for all performance tasks meeting the value for a Small effect, including Able To State Objectives ($d = 0.40$), Assesses Current Situation ($d = 0.47$), and Assesses Capabilities ($d = -0.58$).

The coefficient of determination, r^2, was calculated as an indicator of common variance between the two measurements. The percentage of common variance included Able To State Objectives ($r^2 = 0.08$), Assesses Current Situation ($r^2 = 0.06$), and Assesses Capabilities ($r^2 = 0.15$).

Both the faculty post-clinical assessment and the student post-clinical assessment ranked overall performance consistent with the third competency level describing the "Fully Competent Student" for each of the three tasks. The mean score of the faculty post-clinical assessment was greater than the mean score of the student post-clinical assessment in all tasks. The performance task means for Determining Courses of Action; Faculty Post-Clinical Assessment are shown in Table 15.

Table 15

Determining Courses of Action: Faculty Post-Clinical Assessment

	Faculty Post Assessment (n = 26)		Student Post Assessment (n = 26)	
Performance Task	*M*	*SD*	*M*	*SD*
Able To State Obj…	8.93	1.31	8.73	1.18
Assesses Situation	8.96	1.27	8.92	1.12
Assesses Capabilities	9.19	1.04	9.07	1.12

No performance task measurement met or exceeded the predicted t value (t = 2.060, df = 25, $p < .05$), or was found statistically significant at $p < .05$.

An r value was determined from tables (Spatz, 2001) for the student post-clinical and faculty post-clinical assessment (r = .38, df = 25, $p < .05$). None of the performance task measures met or exceeded the predicted value, or was determined to have been significant at $p < .05$.

The effect size index, Cohen d, for the difference in the means was calculated for each performance task. The accepted index (Spatz, 2001) groups the measures as Small

effect = .20, Medium effect = .50, and Large effect = .80. None of the effect sizes exceeded *d* = .20, the value for a Small effect.

The coefficient of determination, r^2, was calculated as an indicator of common variance between the two measurements. The percentage of common variance included Able To State Objectives ($r^2 = 0.00$), Assesses Current Situation ($r^2 = 0.00$), and Assesses Capabilities ($r^2 =0\ .00$).

Analyze Results

This performance measured assessed the student's ability to examine the problem holistically and apply new knowledge appropriately to include assessing results of earlier decisions or actions and being able to synthesize new knowledge. Students were asked to assess their application of results to the existing hypothesis and their capability to formulate alternate hypotheses. Three performance tasks were assessed in this measure, including (a) Considers The Problem, (b) Synthesizes New Knowledge, and (c) Verifies results and progress of predicted outcomes. The pre-clinical self-assessment was ranked overall as being in the third competency level describing the "Fully Competent Student" for each of the three performance tasks. The post-clinical self-assessment maintained the ranking, although performance mean scores did reflect an increased mean score extending from the middle range ($M = 8.53$) to the upper-lower range ($M = 9.30$) for the competency. The performance task means for Analyze Results are shown in Table 16.

Table 16

Analyze Results: Performance Task Means

	Student Pre-Assessment (n = 26)		Student Post-Assessment (n = 26)	
Performance Task	*M*	*SD*	*M*	*SD*
Considers Problem	7.75	1.21	8.53	1.27
Synthesizes Know…	7.93	1.88	8.69	1.22
Verifies	8.79	1.63	9.30	1.34

One of the performance task measurement exceeded the critical t value (t = 2.060, df = 25, $p < .05$), Considers The Problem (t = 2.551), and was found statistically significant at $p < .05$. Overall, the student post-clinical assessment score reflected an increase over the pre-clinical assessment score.

An "*r*" value was determined from tables (Spatz, 2001) for the student pre-clinical self-assessment and post-clinical assessment (r = .38, df = 25, $p < .05$). Three of the performance task measures exceeded the critical value, including Considers The Problem (r = 0.50), Synthesizes New Knowledge (r = 0.43), and Verifies (r = 0.55), and were determined to have been significant at $p < .05$.

The effect size index, Cohen *d*, for the difference in the means was calculated for each performance task. The accepted index (Spatz, 2001) groups the measures as Small effect = .20, Medium effect = .50, and Large effect = .80. Three performance task measures met or exceeded the value for a Small effect, including Considers The Problem ($d = 0.62$), Synthesizes New Knowledge ($d = 0.47$), and Verifies ($d = 0.34$) Overall, the student post-clinical self-assessment reflected an increase over the pre-clinical self-assessment.

The coefficient of determination, r^2, was calculated as an indicator of common variance between the two measurements. The percentage of common variance included Considers The Problem ($r^2 = 0.25$), Synthesizes New Knowledge ($r^2 = 0.18$), and Assesses Capabilities ($r^2 = 0.31$).

Both the faculty post-clinical assessment and the student post-clinical assessment ranked overall performance consistent with the third competency level describing the "Fully Competent Student" for each of the three tasks. The mean score of the faculty post-clinical assessment was less or equal to the mean score of the student post-clinical assessment in all tasks. The performance task means for Analyze Results; Faculty Post-Clinical Assessment are shown in Table 17.

Table 17

Analyze Results: Faculty Post-Clinical Assessment

	Faculty Post-Assessment (*n* = 26)		Student Post-Assessment (*n* = 26)	
Performance Task	*M*	*SD*	*M*	*SD*
Considers Problem	8.09	2.03	8.53	1.27
Synthesizes Know…	8.70	1.57	8.69	1.22
Verifies	9.29	1.44	9.30	1.34

No performance task measurement met or exceeded the predicted *t* value ($t = 2.060$, $df = 25$, $p < .05$) or was found statistically significant at $p < .05$.

An *"r"* value was determined from tables (Spatz, 2001) for the student post-clinical assessment and the faculty post-clinical assessment ($r = .38$, $df = 25$, $p < .05$). No performance task measure met or exceeded the predicted value or was determined to have been significant at $p < .05$.

The effect size index, Cohen *d*, for the difference in the means was calculated for each performance task. The accepted index (Spatz, 2001) groups the measures as Small effect = .20, Medium effect = .50, and Large effect = .80. One performance task measure, Considers The Problem (*d* = 0.25), exceeded the value for a Small effect.

The coefficient of determination, r^2, was calculated as an indicator of common variance between the two measurements. The percentage of common variance included Considers The Problem ($r^2 = 0.04$), Synthesizes New Knowledge ($r^2 = 0.04$), and Assesses Capabilities ($r^2 = 0.00$).

Developing Alternative Courses of Action/Methods

Students assessed their anticipation of needs with respect to the established primary goals and objectives, and consider if they anticipate unexpected or undesirable outcomes. Assessment was made of student's preparation to respond to undesired outcomes, do they develop plans in advance to mitigate undesired outcomes to include the development of benchmarks to trigger corrective actions as situations or conditions change. Three performance tasks were assessed in this measure, including (a) Anticipates Need, (b) Plans Appropriately, and (c) Marks Progress. The pre-clinical self-assessment was ranked overall as being in the third competency level describing the "Fully Competent Student" for each of the three performance tasks. The post-clinical self-assessment maintained the ranking, although performance mean scores did reflect an increased mean score extending from the middle-upper range (*M* = 8.80) to the upper-lower range (*M* = 9.26) for the competency. The performance task means for Developing Alternative Courses of Action/Methods are shown in Table 18.

Table 18

Developing Alternative Courses of Action/Methods: Performance Task Means

	Student Pre-Assessment (n = 26)		Student Post-Assessment (n = 26)	
Performance Task	*M*	*SD*	*M*	*SD*
Anticipates Need	8.06	1.30	9.03	1.28
Plans Appropriately	7.86	1.27	8.80	1.20
Marks Progress	8.79	1.69	9.26	1.31

Two of the performance task measurement met or exceeded the critical t value (t = 2.060, df = 25, p < .05), including Anticipate Needs (t = 5.284), and Plans Appropriately (t = 4.822), and were statistically significant at p < .05. Overall, the student post-clinical assessment score reflected an increase over the pre-clinical assessment score.

An r value was determined from tables (Spatz, 2001) for the student pre-clinical self-assessment and post-clinical assessment (r = .38, df = 25, p < .05). The performance task measures Anticipates Needs (r = 0.79), Plans Appropriately (r = 0.69), and Marks

Progress (*r* = 0.74) exceeded the critical "*r*" value and were determined to have been significant at $p < .05$.

The effect size index, Cohen *d*, for the difference in the means was calculated for each performance task. The accepted index (Spatz, 2001) groups the measures as Small effect = .20, Medium effect = .50, and Large effect = .80. The performance task measure, Anticipates Needs ($d = 0.74$), Plans Appropriately ($d = 0.76$), and Marks Progress ($d = 0.31$) exceeded the value for a Small effect. Overall, the student post-clinical assessment score reflected an increase over the pre-clinical assessment score.

The coefficient of determination, r^2, was calculated as an indicator of common variance between the two measurements. The percentage of common variance included Anticipates Need ($r^2 = 0.63$), Plans Appropriately ($r^2 = 0.48$), and Marks Progress ($r^2 = 0.55$).

Both the faculty post-clinical assessment and the student post-clinical assessment ranked overall performance consistent with the third competency level describing the "Fully Competent Student" for each of the three tasks. The mean score of the faculty post-clinical assessment was greater than the mean score of the student post-clinical assessment in two tasks, Plans Appropriately and Marks Progress. The performance task means for Developing Alternative Courses of Action/Methods: Faculty Post-Clinical Assessment are shown in Table 19.

Table 19

Developing Alternative Courses of Action/Methods: Faculty Post-Clinical Assessment

	Faculty Post-Assessment (n = 26)		Student Post-Assessment (n = 26)	
Performance Task	*M*	*SD*	*M*	*SD*
Anticipates Need	8.90	1.44	9.03	1.28
Plans Appropriately	9.38	1.45	8.80	1.20
Marks Progress	9.29	1.34	9.26	1.31

No performance task measurement met or exceeded the predicted t value (t = 2.060, df = 25, $p < .05$), or was statistically significant at $p < .05$.

An "*r*" value was determined from tables (Spatz, 2001) for the student pre-clinical self-assessment and post-clinical assessment ($r = .38$, df = 25, $p < .05$). No performance task measure met or exceeded the predicted "*r*" value, or was determined to have been significant at $p < .05$.

The effect size index, Cohen *d*, for the difference in the means was calculated for each performance task. The accepted index (Spatz, 2001) groups the measures as Small effect = .20, Medium effect = .50, and Large effect = .80. The performance task measure, Plans Appropriately (*d* = 0.43), exceeded the value for a Small effect.

The coefficient of determination, r^2, was calculated as an indicator of common variance between the two measurements. The percentage of common variance included Anticipates Need ($r^2 = 0.02$), Plans Appropriately ($r^2 = 0.00$), and Marks Progress ($r^2 = 0.00$).

Responsibility

This performance measure assessed the student's behavior to do what is right, to take corrective action as it is required to correct what is wrong. The students assessed their willingness to make difficult decisions, to admit mistakes, and their willingness to help others and act with compassion. Three performance tasks were assessed in this measure, including (a) Leadership, (b) Selfless Service, and (c) Character. The pre-clinical self-assessment was ranked overall as being in the third competency level describing the "Fully Competent Student" for each of the three performance tasks. The post-clinical self-assessment maintained the ranking for two performance tasks, Leadership and Selfless Service. However, the mean score for Selfless Service reflected a slight decrease on the post-clinical assessment.

The data for the performance task, Character, reflects that the competency rank was increased by one level. The performance task, Character, moved from the third competency level description of a "Fully Competent Student" to the fourth competency level description for "Among The Most Competent Students." The performance task means for Responsibility are shown in Table 20.

Table 20

Responsibility: Performance Task Means

	Student Pre Assessment (n = 26)		Student Post Assessment (n = 26)	
Performance Task	*M*	*SD*	*M*	*SD*
Leadership	9.27	1.30	9.61	1.28
Selfless Service	9.58	0.98	9.50	0.94
Character	9.24	0.87	10.23	2.10

No performance task measurement met or exceeded the critical *t* value ($t = 2.060$, $df = 25$, $p < .05$), or was statistically significant at $p < .05$. Overall, the student post-clinical self-assessment score reflected an increase over the pre-clinical assessment score.

An "*r*" value was determined from tables (Spatz, 2001) for the student pre-clinical self-assessment and post-clinical assessment ($r = .38$, $df = 25$, $p < .05$). One of the performance task measures, Leadership ($r = 0.5661$) exceeded the critical "*r*" value, and was determined to have been significant at $p < .05$.

The effect size index, Cohen *d*, for the difference in the means was calculated for each performance task. The accepted index (Spatz, 2001) groups the measures as Small effect = .20, Medium effect = .50, and Large effect = .80. The performance task measures, Leadership ($d = 0.23$), and Character ($d = 0.61$) exceeded the value for a Small effect.

The coefficient of determination, r^2, was calculated as an indicator of common variance between the two measurements. The percentage of common variance included Leadership ($r^2 = 0.32$), Selfless Service ($r^2 = 0.05$), and Character ($r^2 = 0.00$).

Both the faculty post-clinical assessment and the student post-clinical assessment ranked overall performance consistent with the third competency level describing the "Fully Competent Student" for each of the three tasks. The mean score of the faculty post-clinical assessment was greater than the mean score of the student post-clinical assessment in one task, Selfless Service. The performance task means for Responsibility; Faculty Post-Clinical Assessment are shown in Table 21.

Table 21

Responsibility: Faculty Post-Clinical Assessment

	Faculty Post Assessment (n = 26)		Student Post Assessment (n = 26)	
Performance Task	*M*	*SD*	*M*	*SD*
Leadership	8.93	2.09	9.61	1.28
Selfless Service	9.70	1.48	9.50	0.94
Character	9.51	1.54	10.23	2.10

No performance task measurement met or exceeded the predicted t value (t = 2.060, df = 25, $p < .05$), or was found statistically significant at $p < .05$.

An "*r*" value was determined from tables (Spatz, 2001) for the student post-clinical self-assessment and the faculty post-clinical assessment (r = .38, df = 25, $p <$ .05). No performance task measure met or exceeded the predicted "*r*" value, or was found to have been significant at $p < .05$.

The effect size index, Cohen d, for the difference in the means was calculated for each performance task. The accepted index (Spatz, 2001) groups the measures as Small effect = .20, Medium effect = .50, and Large effect = .80. The performance task measures, Leadership (*d* = 0.38), and Character (*d* = 0.38) exceeded the value for a Small effect.

The coefficient of determination, r^2, was calculated as an indicator of common variance between the two measurements. The percentage of common variance included Leadership ($r^2 = 0.07$), Selfless Service ($r^2 = 0.14$), and Character ($r^2 = 0.01$).

Professionalism

This performance measure assessed the student's perception of morals, values, attitudes as they influence clinical decisions and recommendations affecting the status of health and quality of life of patient animals. Six performance tasks were assessed, including, (a) Values, (b) Ethics, (c) Reflection of clinical problem solving logic, (d) Humanitarian Qualities, (e) Attitude, and (f) Critical Appraisal. The data for the two performance tasks, Values and Ethics, reflect that the competency rank was increased by one level. Values and Ethics moved from the third competency rank level description of a "Fully Competent Student" in the pre-clinical assessment to the fourth competency level description of "Among The Most Competent Students" in the post-clinical assessment. The remaining four performance tasks retained the third competency level rank description for both the pre-clinical and post-clinical assessments. The performance task means for Professionalism are shown in Table 22.

Table 22

Professionalism: Performance Task Means

	Student Pre-Assessment (n = 26)		Student Post-Assessment (n = 26)	
Performance Task	*M*	*SD*	*M*	*SD*
Values	9.41	1.29	10.03	1.37
Ethics	9.96	1.49	10.34	1.26
Reflection	9.10	1.14	9.53	1.24
Humanitarian Qual…	9.34	1.20	9.96	1.28
Attitude	9.41	1.32	9.80	1.38
Critical Appraisal	9.51	1.35	9.88	1.24

One of the performance task measures, Humanitarian Qualities (t = 2.384) exceeded the critical t value (t = 2.060, df = 25, $p < .05$), and was statistically significant at $p < .05$. Overall, the student post-clinical assessment score reflected an increase over the pre-clinical assessment score.

An *"r"* value was determined from tables (Spatz, 2001) for the student pre-clinical self-assessment and post-clinical assessment (r = .38, df = 25, $p < .05$). Six of the performance task measures, including Values (r = 0.40), Ethics (r = 0.67), Reflection (r = 0.52), Humanitarian Qualities (r = 0.45), Attitude (r = 0.70), and Critical Appraisal (r = 0.40) met or exceeded the critical "*r*" value, and were determined to have been significant at $p < .05$.

The effect size index, Cohen *d*, for the difference in the means was calculated for each performance task. The accepted index (Spatz, 2001) groups the measures as Small effect = .20, Medium effect = .50, and Large effect = .80. The performance task measures, Values (d = 0.46), Ethics (d = 0.27), Reflection (d = 0.36), Humanitarian Qualities (d = 0.49), Attitude (d = 0.29), and Critical Appraisal (d = 0.28) exceeded the value for a Small effect.

The coefficient of determination, r^2, was calculated as an indicator of common variance between the two measurements. The percentage of common variance included Values (r^2 = 0.16), Ethics (r^2 = 0.44), Reflection (r^2 = 0.27), Humanitarian Qualities (r^2 = 0.20), Attitude (r^2 = 0.50), and Critical Appraisal (r^2 = 0.16).

Both the faculty post-clinical assessment and the student post-clinical assessment ranked overall performance consistent with the third competency level describing the "Fully Competent Student" for each of the six tasks. The mean score of the faculty post-clinical assessment was greater than the mean score of the student post-clinical assessment in one task, Reflection. The performance task means for Professionalism; Faculty Post-Clinical Assessment are shown in Table 23.

Table 23

Professionalism: Faculty Post-Clinical Assessment

	Faculty Post Assessment (n = 26)		Student Post Assessment (n = 26)	
Performance Task	*M*	*SD*	*M*	*SD*
Values	9.58	1.70	10.03	1.37
Ethics	9.77	1.70	10.34	1.26
Reflection	9.61	1.35	9.53	1.24
Humanitarian Qual…	9.64	1.49	9.96	1.28
Attitude	9.58	1.52	9.80	1.38
Critical Appraisal	9.61	1.54	9.88	1.24

No performance task measures met or exceeded the critical t value (t = 2.060, df = 25, $p < .05$), or was found statistically significant at $p < .05$. Overall, student post-clinical assessment scores reflected an increase over the pre-clinical assessment scores.

An r value was determined from tables (Spatz, 2001) for the student pre-clinical self-assessment and post-clinical assessment (r = .38, df = 25, $p < .05$). No performance task measure met or exceeded the predicted *r* value, or was found to have been significant at $p < .05$.

The effect size index, Cohen *d*, for the difference in the means was calculated for each performance task. The accepted index (Spatz, 2001) groups the measures as Small effect = .20, Medium effect = .50, and Large effect = .80. The performance task measures, Values ($d = 0.29$), Ethics ($d = 0.38$), Reflection ($d = 0.05$), Humanitarian Qualities ($d = 0.22$), Attitude ($d = 0.15$), and Critical Appraisal ($d = 0.19$) exceeded the value for a Small effect.

The coefficient of determination, r^2, was calculated as an indicator of common variance between the two measurements. The percentage of common variance included Values ($r^2 = 0.11$), Ethics ($r^2 = 0.00$), Reflection ($r^2 = 0.07$), Humanitarian Qualities ($r^2 = 0.00$), Attitude ($r^2 = 0.00$), and Critical Appraisal ($r^2 = 0.00$).

Interpersonal Skills

These performance measures assessed the student's ability to establish positive relationships with others, establish rapport with clients, and to effectively communicate and articulate philosophies and values. Assessment also included the ability to be considerate of the needs of others and to identify with them on a personal basis. Four performance tasks were assessed in this measure, including (a) Establishes Relationships, (b) Communication Skill, (c) Empathy, and (d) Respects Others. The pre-clinical assessment ranked all performance tasks in the third competency level description of a "Fully Competent Student." The data for the post-clinical assessment revealed that two performance tasks, Establishes Relationships and Empathy, were ranked in the fourth competency level describing "Among The Most Competent Students." The remaining two performance tasks retained their position in the third competency level describing a "Fully Competent Student" with a slight increase in mean. The performance task means for Interpersonal Skills are shown in Table 24.

Table 24.

Interpersonal Skills: Performance Task Means

	Student Pre-Assessment (n = 26)		Student Post-Assessment (n = 26)	
Performance Task	*M*	*SD*	*M*	*SD*
Est. Relationships	9.58	1.32	10.19	1.02
Communication Skill	8.62	1.49	8.76	2.33
Empathy	9.79	1.04	10.11	1.33
Respects Others	9.24	1.24	9.61	1.32

One of the performance task measures, Establishes Relationships (t = 2.486), exceeded the critical t value ($t = 2.060$, $df = 25$, $p < .05$), and was statistically significant at $p < .05$. Overall, the student post-clinical self-assessment reflected an increase over the pre-clinical assessment score.

An *"r"* value was determined from tables (Spatz, 2001) for the student pre-clinical self-assessment and post-clinical assessment ($r = .38$, $df = 25$, $p < .05$). Three of the performance task measures, including Establishes Relationships ($r = 0.6198$), Empathy ($r = 0.53$), and Respects Others ($r = 0.55$) exceeded the predicted "*r*" value, and were determined to have been significant at $p < .05$.

The effect size index, Cohen *d*, for the difference in the means was calculated for each performance task. The accepted index (Spatz, 2001) groups the measures as Small effect = .20, Medium effect = .50, and Large effect = .80. The performance task measures, Establishes Relationships ($d = 0.51$), Empathy ($d = 0.26$), and Respects Others ($d = 0.29$) exceeded the value for a Small effect.

The coefficient of determination, r^2, was calculated as an indicator of common variance between the two measurements. The percentage of common variance included Establishes Relationships ($r^2 = 0.38$), Communication Skill ($r^2 = 0.04$), Empathy ($r^2 = 0.28$), and Respects Others ($r^2 = 0.30$).

Both the faculty post-clinical assessment and the student post-clinical assessment ranked overall performance consistent with the third competency level describing the "Fully Competent Student" for each of the four tasks. The mean score of the faculty post-clinical assessment was greater than the mean score of the student post-clinical assessment in two tasks, Communication Skill and Respects Others. The performance task means for Interpersonal Skills; Faculty Post-Clinical Assessment are shown in Table 25.

Table 25

Interpersonal Skills: Faculty Post-Clinical Assessment

	Faculty Post Assessment (n = 26)		Student Post Assessment (n = 26)	
Performance Task	*M*	*SD*	*M*	*SD*
Est. Relationships	9.06	1.61	10.19	1.02
Communication Skill	8.93	2.01	8.76	2.33
Empathy	9.48	1.43	10.11	1.33
Respects Others	9.64	1.64	9.61	1.32

One of the performance task measures, Establishes Relationships (t = 4.697) exceeded the critical t value (t = 2.060, df = 25, $p < .05$), and was statistically significant at $p < .05$.

An r value was determined from tables (Spatz, 2001) for the student pre-clinical self-assessment and post-clinical assessment (r = .38, df = 25, $p < .05$). One performance task measure, Establishes Relationships (r = 0.54), exceeded the predicted "r" value, and was determined to have been significant at $p < .05$.

The effect size index, Cohen d, for the difference in the means was calculated for each performance task. The accepted index (Spatz, 2001) groups the measures as Small effect = .20, Medium effect = .50, and Large effect = .80. The performance task measures, Establishes Relationships (d = 0.83), Communication Skill (d = 0.07), Empathy (d = 0.45), and Respects Others (d = 0.01) exceeded the value for a Small effect.

The coefficient of determination, r^2, was calculated as an indicator of common variance between the two measurements. The percentage of common variance included Establishes Relationships (r^2 = 0.30), Communication Skill (r^2 = 0.08), Empathy (r^2 = 0.00), and Respects Others (r^2 = 0.08).

Instrument Sensitivity and Stability

A primary objective in this study was to develop an instrument that possessed reliable sensitivity to measure student problem-solving skill, and possessed reliable stability to allow it to be applied in multiple clinical services. Further testing of the instrument, with emphasis on its application within a referral service diagnosing complex, non-surgical cases, will be necessary to achieve the objective in full measure. The preliminary results of this study, however, are encouraging.

The data show that student self-assessment scores increased across all measures following the two week clinical rotation; an indicator of the instrument's ability to detect changes in student self-perceptions of their problem-solving skill. Additionally, comparison between the scores of the faculty evaluator post-clinical assessment, and the student post-clinical assessment, shows only slight variation in the overall score and very similar tracking of individual scores across the length of the instrument. The relative similarity between the post-clinical means gives supportive evidence in favor of an initial statement of confidence in the stability of the instrument. A graph of the comparison of means is shown in Figure 1.

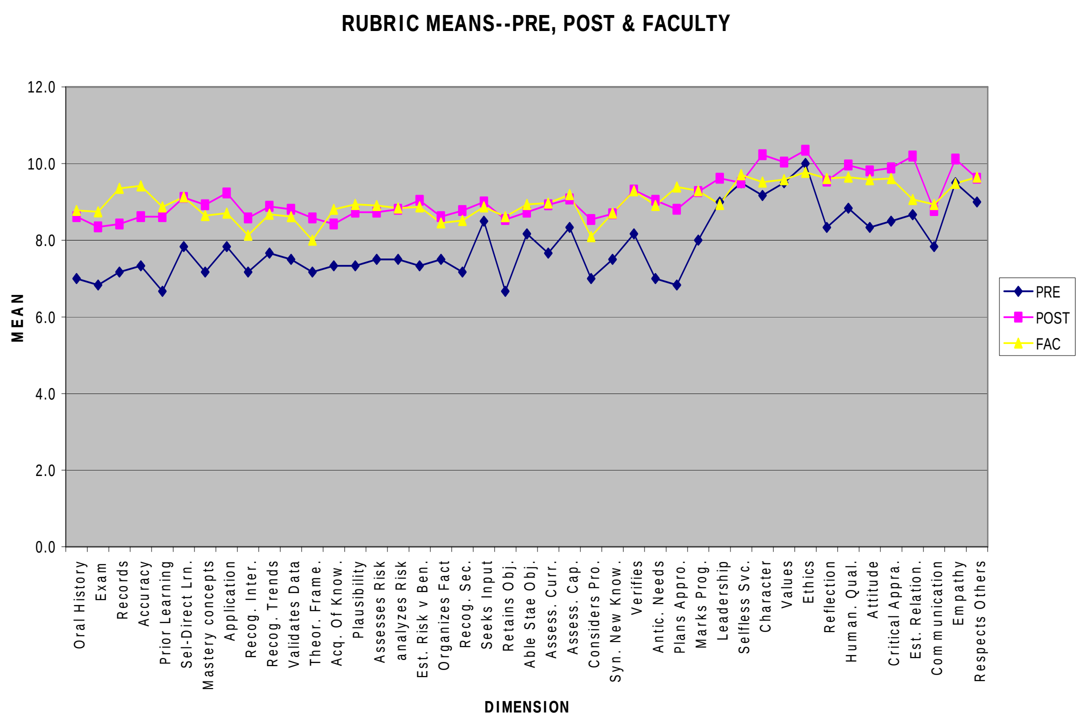

Figure 1. Comparison of the Means: Pre-Clinical and Post-Clinical Assessments.

The descriptive statistics show that the mean increased between student pre-clinical self-assessment (*M* = 8.43, *SD* = 1.36) and student post-clinical self-assessment

(*M* = 9.10, *SD* = 1.32). The faculty post-clinical assessment (*M* = 9.01, *SD* = 1.52) tracks very closely with the student post-clinical self-assessment.

Further analyses included comparisons of the summative correlation ratios of (a) the student pre-clinical and post-clinical self assessment, (b) between the faculty post-clinical assessment and the student pre-clinical assessment, and (c) the faculty post-clinical assessment and the student post-clinical assessment.

Summative correlations in each of the 12 performance measures were also examined for the faculty post-clinical assessment compared to the student post-clinical assessment.

- The student pre-clinical/post-clinical self-assessment summative correlation *r* resulted in a very strong ratio ($r = .93$, $p < .01$, $df = 41$) of the means across the measures in the instrument.
- The faculty post-clinical assessment/student pre-clinical self-assessment summative correlation *r* resulted in a strong ratio ($r = .73$, $p < .01$, $df = 41$) of the means across the measures in the instrument.
- The faculty post-clinical assessment/student post-clinical self-assessment summative correlation *r* resulted in a very similar, strong ratio ($r = .71$, $p < .01$, $df = 41$) of the means across the measures in the instrument.

The summative correlations between the12 performance measures of the student post-clinical self-assessment compared with the faculty post-clinical assessment resulted in a much weaker *r* value, indicating relatively small correlations that were difficult to interpret. The correlation range extended from, $r = -0.12$, $p = 0.53$ to $r = 0.29$, $p = 0.14$. Preliminary analysis suggests that the weaker correlation ratios may be indicative of the need to strengthen the individual performance task descriptors within the 12 performance measures of the instrument, or the faculty assessment of individual student performance may be less accurate at the specific measure than it is across the entire instrument. Consideration should also be given to the possibility that the student's responses within individual cells may be reflecting uncertainty in their own competence or uncertainty with the instrument.

CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Summary

The reason for this study was to provide evidence that fourth year veterinary medical students possess competency in specified clinical skills and concepts at the time of graduation. The immediate direct recipient of the results of the study is the College of Veterinary Medicine and Biomedical Sciences at Texas A&M University.

This study sought to measure competency in diagnostic problem solving skill, specifically an increase in the perceived competency level, as a result of clinical instruction using live-patient animals. To answer the question, are students clinically competent at the time of graduation, six research objectives were developed to collect data and establish evidence to support a confirming statement.

. Measurements were taken by students in a pre-clinical and a post-clinical self-assessment using a rubric designed for this study. A comparison score of the post-clinical assessment was generated by the faculty instructor and applied as authentication of the reliability of the rubric. Descriptive statistics were collected as evidence to support confidence in the clinical competency of fourth year veterinary students at graduation.

The study was modeled as Research and Development (R&D) in design of the rubric, and for the initial gathering of data to establish confidence in the emerging development of the instrument. The ten step Systems Approach Model of Educational Research and Development design by Walter Dick and Lou Carey (Gall, Borg, & Gall,

1996) provided the theoretical outline and identification of the major process steps. This study was intentionally limited by design to stop at the third step, "Identify Entry Behaviors, Characteristics."

The preparatory phase of this study included completion of the first three research objectives (Step 1 and Step 2 of the Systems Approach Model) as necessary precursors to the actual sampling and collection of data. Research objective one required obtaining approval and buy-in of the Dean, College of Veterinary Medicine and Biomedical Sciences prior to approaching faculty or staff about the concept. Research objective two required that a faculty advisory panel be identified and formed to provide internal guidance to the principal investigator, and advise on any topic or item relevant to the research being proposed. A major objective specific to the advisory panel was the need to propose a description or a definition of clinical competency that was applicable to fourth year veterinary students at the time of graduation. The panel's description surfaced three themes that were descriptive: (a) competency was situational, (b) competency was described by ability, and (c) the definition of competency for a fourth year veterinary student was descriptive for skill associated with primary patient care. Research objective three required the development of an instrument to measure competency in problem solving skill. The description of competency developed by the faculty panel assisted in verifying the parameters applied to the rubric.

Conclusions

The descriptive statistics derived from the collected data reflected an increase in the mean between the pre-clinical (*M* = 8.43, *SD* = 1.36) and post-clinical (*M* = 9.10, *SD* = 1.32) self-assessments. The increase was sufficiently large (a statistically significant change) that the researcher is confident that the rubric was sensitive to a perceived change in student self-assessment. Overall, the change in the aggregate mean did not reflect a change in the student's self perception of their level of competency. Students entered the clinical service rotation thinking they were "Fully Competent Students," and completed the rotation with the same perception. The disaggregated means, however, reflect that students perceived they had strengthened their intrinsic values and beliefs in the affective domain and began to elevate their competency rank on the post-clinical self-assessment at the highest level characterization of "Among The Most Competent Students." Evidence of this evolving perception is found in the score mean. The five highest means on the post-clinical assessment were posted for the tasks Character, Values, Ethics, Establishes Relationships, and Empathy under the performance measures for Responsibility, Professionalism, and Interpersonal Relationships. All were classified at the highest competency level on the post-clinical assessment.

Ranked among the five lowest means for the post-clinical assessment were the performance tasks Obtain Oral History, Examination, Prior Learning, Recognizes Interrelationships, and Organizes Facts. Each task, however, when examined on the pre-post assessment was significant at $p < .05$ for the t value, which is indicative of a meaningful change in the student's assessment score.

The faculty comparison post-clinical assessment reflected the five highest means to include the performance tasks Ethics, Humanitarian Qualities (tied with Respects Others), Selfless Service, Critical Appraisal, and Attitude (tied with Values). Conversely, the five lowest means included the performance tasks Theoretical Framework, Considers The Problem, Recognizes Interrelationships, Organizes Facts, and Recognizes Secondary Outcomes. None of the means attained significance at $p < .05$ for the t value.

Research objective four required that a *t*-test be calculated for correlated samples repeated measures. A total of 43 performance tasks were measured across the rubric. A *t*-test was calculated to determine if a significant difference existed between means. The predicted t value ($t = 2.060$, $df = 25$, $p < .05$) was determined from tables (Spatz, 2001). The performance task data revealed that 19 measurements (44%) exceeded the critical t value and were statistically significant at $p < .05$. The distribution of the significant t values was primarily in the tasks (89%) reflecting performance measures in the cognitive domain (Initial Assessment, Knowledge, Analyze Data, Develop Hypothesis, Assessing & Assigning Risk, Making Decisions, Determine Course of Action, Analyze Results, and Develop Alternative Course of Action). Two tasks (11%) were significant in performance measures of the affective domain (Professionalism and Interpersonal Skills).

The comparison faculty to student post-clinical assessment *t*-test revealed two tasks that were statistically significant at $p < .05$. The performance task, Accuracy, located in the cognitive domain under the performance measure Initial Assessment, and the performance task, Establishes Relationships, located in the affective domain under the performance measure for Interpersonal Skills, were the only tasks shown to be statistically significantly.

Research objective five examined the relationship between live-animal instruction and the difference in the scores between the student's pre-clinical and post-clinical self-assessment. Examination was also made of the relationship between the student's post-clinical assessment and the faculty post-clinical assessment. A Pearson product-moment correlation coefficient (*r*) was calculated to establish evidence of a relationship ($r = 0.38$, $df = 25$, $p < .05$).

The student pre-clinical, post-clinical self assessment resulted in 28 performance tasks (65%) meeting or exceeding the critical value ($r = 0.38$) and attaining significance at $p < .05$. The effect size of the *r* value was compared against established convention (Spatz, 2001) identifying a Small effect $r = .10$, Medium effect $r = .30$, and Large effect $r = .50$. The collective *r* values were determined to have a large effect size given that the range of the values extended from $r = 0.38$ to $r = 0.79$. Statistically significant values of *r* were distributed relatively evenly across the rubric, although three performance measures characterized as representative of the affective domain, Responsibility, Professionalism, and Interpersonal Skills contained 10 out of 13 possible *r* values significant at $p < .05$, and having a an effect size $r = .40$ or larger.

The relationship of faculty and student post-clinical assessment identified only one performance task, Establishes Relationships (*r* = 0.54), located in the performance measure Interpersonal Skills, having attained statistical significance at $p < .05$.

Research objective six examined the effect size index, Cohen *d*, for the difference in the means of the performance tasks, and the coefficient of determination, r^2, as an indicator of common variance between the student pre-clinical and the post-clinical self assessment. Effect sizes were ranked according to accepted convention as Small effect size = .20, Medium effect size = .50 and Large effect size = .80 (Spatz, 2001). The ranking of effect sizes resulted in 12 (28%) measures having a Small effect size, 22 (51%) measures having a Medium effect size, and nine (21%) measures having a Large effect size. The most obvious occurrence (eight of 13) of a clustered Small effect size was present in the three performance measures Responsibility, Professionalism, and Interpersonal Skills. Overall, thirty-one effect sizes (72%) were ranked greater than .33 and were considered meaningful.

The coefficient of determination, r^2, was calculated to allow examination of the proportion of variance the student pre-clinical and post-clinical assessments have in common. The range of r^2 extended from 0.00 to 0.63 with individual values distributed across the length of the rubric.

The Cohen *d* observed for the faculty post-clinical assessment resulted in 32 (74%) measures having a Small effect size, nine (20%) measures having a Medium effect size, and two (4%) having a Large effect size. Ten (23%) measures had an effect size great than .33 and were considered meaningful.

The coefficient of determination, r^2, was calculated to allow examination of the proportion of common variance between the faculty and student post-clinical assessments. The range of r^2 extended from 0.00 to 0.30 with individual variance distributed across the rubric.

The compiled statistics indicate that the rubric possessed stability across the range of measures being taken as indicated by the similarity in post-clinical assessment score comparisons between the student self-assessment and the faculty assessment. The change in mean scores between the student pre-clinical and the post-clinical assessment supported the initial assumption that a perceived change in competency could be detected and measured. The mean score differences between the pre-clinical and post-clinical assessments were shown to have statistical significance in almost half the performance tasks and were distributed evenly across the length of the instrument. Practical significance, in addition to statistical significance, was evident in the performance tasks descriptive of affective domain measures for intrinsic values and beliefs. Students showed a tendency to elevate their self-description of competency from a “Fully Competent Student” to “Among The Most Competent Students” after completing the clinical rotation.

Examination of the Pearson product-moment correlation coefficient indicates that a relationship is evident between student interaction with live-patients and an increase in competency in problem solving skill. The relationship is positive and moderately strong although not homogeneously present or detectable throughout the instrument. Multiple causes could be attributed to the lack of homogeneity and consideration needs to be given to strengthening the design. However, with respect to performance tasks that did not reflect a relationship, consideration should be given that the task may not have been stimulated sufficiently by the type of surgical experience presented to the students.

The results of the Cohen *d* provided evidence of a strong effect size with meaningful application for comparison of the differences in score means. These results offer further support of the assumption that the instrument was detecting actual increases in the strength of student competency in problem solving skill as a result of student interaction with live-patient animals.

The results of the examination for the coefficient of determination (r^2) to establish the proportion of common variance were inconclusive. Values for variances extended over a wide range and were distributed across the length of the rubric. The wide range of common variance may be indicative of weakness in the descriptive narrative within performance measure cells, or student uncertainty with their own perception of their true level of competence compared with reduced accuracy in faculty assessment at the individual task level.

Discussion

The rubric for assessing clinical competency in problem-solving skill for a fourth-year veterinary student has provided evidence that it is sufficiently stable and sensitive as an exploratory instrument to warrant confidence in continuing its development to the next stage (Step 4 and beyond in the Systems Approach Model). Before attempting to advance to Step 4, however, questions should be framed and hypotheses developed to address results obtained in this study. One question is, why did not all performance task measures generate a significant *r* value and provide evidence of competence in problem solving as a result of student interaction with a live-patient animal? The disaggregated data show that six of 12 performance measures failed to meet or exceed the predicted *r* value (*r* = .38) for at least 50% of the performance tasks within each performance measure. The performance measures include Initial Assessment, Analyze Data, Develop Hypothesis, Assess & Assign Risk, Determine Course of Action, and Responsibility. Most notable was the performance measure Assess & Assign Risk, which had no performance task (four tasks total) meet or exceed the predicted *r* value.

A plausible explanation for this result might consider that the inherent nature of elective surgery cases lack adequate stimulus in certain problem-solving measures that acted as a limiting condition specific to the nature of the cases, rather than the lack of sensitivity in the design of the instrument. The measurements were obtained from students assigned to the General Surgery service. The specific nature of the service is to develop surgical skill, behaviors, and practices commensurate with professional surgical standards. The cases being managed by the students are generally considered to be physically free of disease, physiologically normal, and very low risk for hidden or underlying complicating pathology. Although the student is taught and expected to perform a systematic physical examination on all patients assigned to their care, the probability is very low that the examination will reveal unexpected complications or conditions requiring decisions or actions outside the normal parameters outlined for preparing and performing the prescribed surgical procedure. The surgical procedure presents a very low risk to patient health or to the student surgeon's performance evaluation given the preliminary examination and patient profile fall within the normal range.

Contrast the General Surgery service experience with the same student assigned to a referral service receiving patients with multiple disease conditions with varying complexity to the problem. In such a circumstance the student would be expected to evaluate the condition of an animal, create a rule-in and rule-out list of differentiated variables, and prescribe a patient management regimen in specific detail. The student's skill in making the initial assessment, developing a hypothesis, and assessing or assigning risk to the patient as a result of treatments would be expected to stimulate a significantly higher response in the same performance measures that were only lightly stimulated by the elective surgery patient.

A second question that needs to be examined is how much variance in the measurement is attributable to confidence, rather than competence? Examination of the data shows that the coefficient of determination (r^2), the proportion of common variance, for the student pre-clinical, post-clinical, self-assessment ranged from $r^2 = 0.00$ to $r^2 = 0.63$ ($M = 0.22$), while the faculty post-clinical comparison with the student post-clinical assessment ranged from $r^2 = 0.00$ to $r^2 = 0.30$ ($M = .03$).

The reasons for explaining the variances, common variance and independent variance, are numerous and are generally associated with complexity of the medical or surgical procedure, the clinical environment and fluctuation in conditions on given days or locations, student uncertainty with the rubric, or uncertainty about their own level of competency when attempting to interpret the rubric. Other common variables that conceivably would stabilize the measurements and contribute to a high r^2 value would include subject knowledge, prior experience, high case count, and low degree of complexity. Considerations for the low range and mean of common variance in the faculty post-clinical assessment would conceivably be associated with practice experience and situational knowledge of the faculty surgeon attained over ten years in practice as a general practitioner surgeon. Another consideration would include the faculty evaluator's gain in familiarity and confidence in interpreting the subtleties of the rubric descriptors each time an assessment was completed. The faculty evaluator overall completed 26 assessments compared to two for the student. It was expected that the faculty evaluator would gain in proficiency as each assessment was completed.

The two phenomena, (a) the low relationship (*r*) between change in student competence as result of live-patient interaction, and (b) the difference in the range of common variance shared between student self-assessment and faculty assessment, were evident but not fully explained to the satisfaction of the researcher. The conditions and limitations associated with case complexity and challenge associated with the General Surgery have been described. Other considerations must also be given to the development of the instrument, and the design characteristics.

The instrument was applied ahead of the completion of a pilot study originally proposed for this research. The proposed pilot study was cancelled as a result of clinical schedule conflicts and non-availability of faculty participants during the limited time available. Cancellation of the pilot study prevented exploration of strengths and weaknesses of the design and delayed the discovery process until after the research trial had been completed. Development of the instrument was also impacted by late information (i.e. 48 hours preceding the start of the first clinical rotation) from the Web-page manager advising the researcher that the instrument would not post on the Web-page as originally proposed. Descriptive text within the performance tasks cells was truncated by the program software, thereby preventing the instrument from being fully displayed on the Web-page. Competency descriptors had to be quickly re-worded to satisfy software parameters before the instrument was acceptable for posting as a Web-page. Detail was lost and delineations confused as a result of this exigency.

The selection of the clinical service chosen for this study, General Surgery, was the result of favorable opportunity rather than a product of design. The researcher anticipated from the beginning that the reliability of the results would be questioned, and best accepted, if the instrument was challenged by a clinical service that routinely accepted referral cases with a high degree of difficulty in problem-solving. Satisfying that requirement, however, was dependent on a number of complimentary conditions being present in the right order and at the correct time. Controlling those conditions was beyond the capabilities of the researcher and as a result, the only opportunity available became the opportunity of choice. The determination of sensitivity and accuracy of the instrument will rely on a more robust trial gained from student interactions with patients examined in a more diagnostic oriented service with authentication from at least two faculty evaluators providing blind assessments of the student's problem-solving skills. Information obtained in this method will likely be more complete and potentially provide better explanation of the role that common variations have in contributing to the uncertainty of student competence in problem-solving skill.

A question deserving discussion includes, what evidence exists to support the presumption that student responses are reliable? The evidence is provided by the student responses in the self-assessment. If students had been concerned only with providing a numerical score, it would seem logical to assume that the scores would have defaulted to a safe position indicating a consistent score within the range of a "Fully Competent Student" (i.e. M = 7-9), if not better. Examination of disaggregated individual scores shows that students provided candid self-assessment scores across a wide distribution. The range of individual scores across performance tasks varied from M = 4.0 to M = 12.0, with individual summative means ranging from M = 6.9 to M = 9.7 for the pre-clinical self-assessment. The ranges increased across the individual performance tasks from M = 5.0 to M = 12.0 and also on the summative means from M = 7.2 to M = 10.7 for the post-clinical self-assessments. The researcher believes the scores would not have shown as much variability if the students were inclined to satisfy only the program rather than provide a reliable self-assessment.

Additional evidence is provided by the general attitude and genuine enthusiasm displayed by the students in anticipation of participating in the study. Prior to the start of the study, the researcher was personally visited by three different students seeking to obtain an informed consent authorization form. The students advised that they would not be present for the scheduled pre-clinical orientation assembly and wanted to insure that they provided informed consent to be included in the sample group. Another student visited the researcher after the start of the academic year and requested that he be provided an informed consent form; he stated that the forms depleted before he could obtain one during the orientation assembly. Overall, the student request for informed consent forms was greater than the number of forms available for distribution during the assembly.

Veterinary students are credited with being mature adults possessing life skills and experiences enabling them to make rational and responsible decisions concerning personal involvement in extra-mural and voluntary activities. Participation in this study was completely voluntary and without obligation to the researcher or the CVM-BS in any way. The researcher is fully confident that a veterinary student who had volunteered to participate in a self-assessment would have provided a fair and honest accounting of their skills and abilities.

Recommendations

Further development is recommended. Future research should include external evaluation for inter-rater reliability using multiple faculty evaluators in a clinical service that is predominantly referral case specific, and which routinely receives complex and challenging diagnostic clinical problems.

The fourth-year practicum is separated between species (large animal, small animal, mixed practice and food animals) and between clinical disciplines (internal medicine, soft tissue surgery, orthopedic surgery, elective surgery, oncology, neurology, cardiology etc.). In certain disciplines species differentiation exists and have potential to manifest variability differently. Not only are student variables (knowledge, species-specific experience and animal familiarity, self-confidence) affecting the reliability of the instrument, but case complexity also. Referral services are designed to receive and diagnose the more complex clinical problems seen in the general practice environment, while the community practice service receives the “well patient” and annual vaccination population originating within the local community. The stimulation in personal values and beliefs vary with each situation.

The exploratory design of this study limited the application of the instrument to a single service, General Surgery. The faculty assessment, compared to the student post-clinical self assessment, provided evidence of the stability of the instrument in this limited application, and established confidence in the intra-rater reliability. The next logical assessment would be to test the instrument in a clinical service offering a broad spectrum of disease differentiated by varying complexities of diagnosis and case management. Completing this step simultaneously in a separate clinic or a different service within the same clinic (i.e. large animal medicine vs feline internal medicine) would serve not only to identify variables affecting sensitivity of the instrument but would also serve to establish inter-rater reliability for application of the instrument by comparing evaluator scores between assessments.

The second recommendation references the instrument. The rubric itself should be re-examined to better describe and identify the distinguishing behavior within the performance tasks. Situational context and criteria for successful performance (establishing standards) are necessary end items to prepare the instrument and evaluators for advancement to Step 4 of the Systems Approach Model. Remaining ambiguities need to be removed, and sharper delineation appropriately made between competency level descriptions.

The final recommendation is to expand the membership of the expert panel faculty advisors to include large animal clinicians, and fourth year students. The expanded membership would be more representative of the stakeholder interest in describing performance objectives, and serve to assign ownership for the content and the application of the instrument within the curriculum.

Implications

The findings of the study generate confidence that the instrument has application within the professional curriculum for veterinary medicine. Specific findings in the perceived increase in the personal values and belief mediated skills suggest that veterinary students find positive reinforcement of intrinsic values when they are clinically successful with the case outcome. In the instance of this study, the students were clinically responsible for surgical cases that were expected to recover and join families immediately after release from veterinary care. The results of this study might immediately be considered as a discussion point to examine ways to expand the outreach and partnership agreements with humane societies and animal shelters to broaden student participation in clinical care and treatment of animals that have a need for special consideration.

In another instance, the rubric might serve as a talking point to stimulate examination of the current grading of fourth-year students and consider the implication that performance outcomes could be developed in some measure to reduce subjectivity currently applied to the process. While wholesale changes of any sort would conceivably be a long term process, the instrument could very well serve as the focal point of discussion.

Results from the assessment will conceivably be shared with members of the committees for recruitment, admissions, and curriculum. Evidence provided by the assessment has potential to stimulate new research in education theory that could be incorporated into the fourth-year clinical practicum in a broader scope.

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APPENDIX A

INSTITUTIONAL REVIEW BOARD CONSENT FORM

CONSENT FORM
Research Proposal

Assessing Student Problem Solving Competency In A Problem Based Learning Curriculum

You have been asked to participate in a research study to assess senior veterinary student competency in developing a clinical diagnosis (specifically problem solving skills). You were selected to be a possible participant because the American Veterinary Medical Association-Council of Education (AVMA-COE) is requiring the College of Veterinary Medicine, Texas A&M University, to demonstrate a process and method to evaluate the professional skills base and level of clinical competency of its students at graduation. A very limited number of clinical service groups in either the Large Animal Clinic or the Small Animal Clinic satisfy the research requirements for numbers of students and duration of study that the sampling plan requires; your clinical service group is among the few. A total of 30 students will be asked to participate in this study. The purpose of this study is two fold: the researcher expects to (a) define clinical competency, and (b) to development an instrument to assess and measure the competency level of students problem solving skill.

If you agree to be in this study, you will be asked to provide a self-assessment of your problem solving skill at the beginning of your clinical rotation (the pre-clinical experience at 24 hours) and a second self-assessment at the conclusion of your rotation (post clinical experience). A rubric has been developed to measure performance levels in problem solving. The rubric currently exists as a paper document, however, attempts are being made to develop a Web based on-line version to enhance security, student confidentiality, and user friendliness. Each participating student will be asked to use the rubric to guide the self-assessment and to score their level of skill. The faculty clinician in charge of the service will also score the participating students at the end of the service rotation (post experience assessment) using the same rubric method. Scores will be summed and descriptive statistics developed. No other methods will be used to record the self-assessment rubric, i.e. no audio or video tapes will be made. This study will take approximately 30 minutes for each self-assessment, with a total of two self-assessments being requested on part of the student. The self-assessments will be made at the beginning of the clinical rotation (approx. day 2) and again at the conclusion of the clinical rotation (approx. day 14). The risks associated with this study are minimal in all respects. No risk is assigned or associated to a student’s academic grade or class ranking as a result of participating in this study. Every student will be provided a coded identity to protect their confidentiality. All assessment records and coded journal entries will be recorded separately and maintained in a locked file cabinet in the Principal Investigator’s (P.I.) office. A risk assessment has been made and it has been determined that there is no more than minimal risk involved to a breach of the student’s confidentiality and that this risk is unlikely to occur. The benefits of participation are limited to the veterinary student’s ability to gain advance information and familiarity of performance variables used to evaluate clinical competency. Students will be free to use the advance information to enhance or improve their personal performance in diagnosing and treating patient animals assigned to their care.

You will not receive compensation of any type for participation in this study. Participation is totally voluntary; you may withdraw at any time you choose.

This study is confidential. Every student will be provided a coded identity to protect their confidentiality. All assessment records and coded journal entries will be recorded separately and maintained in a locked file cabinet in the Principal Investigator's (P.I.) office. The records of this study will be kept private. No identifiers linking you to the study will be included in any sort of report that might be published. Research records will be stored securely and only the P. I. (Noberto F. Espitia) will have access to the records. No audio or video tapes will be made during this study. Your decision whether or not to participate will not affect your current or future relations with Texas A&M University. If you decide to participate, you are free to refuse to answer any of the questions that may make you uncomfortable. You can withdraw at any time without your relations with the University, job, benefits, etc., being affected. You can contact Noberto F. Espitia (the P.I.), College of Veterinary Medicine, Small Animal Clinical Sciences (845-9053), nespitia@cvm.tamu.edu or the Graduate Committee Chair, Kim E. Dooley, PhD., Assoc. Prof. & Assoc. Dept. Head for Graduate Programs and Research, Dept. of Ag. Leadership, Education and Communications (862-7180), k-dooley@tamu.edu with any questions about this study.

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This research study has been reviewed by the Institutional Review Board - Human Subjects in Research, Texas A&M University. For research-related problems or questions regarding subjects' rights, you can contact the Institutional Review Board through Ms. Melissa McIlhaney, IRB Program Coordinator, Office of Research Compliance, (979)458-4067, mcilhaney@tamu.edu.

Please be sure you have read the above information, asked questions and received answers to your satisfaction. You will be given a copy of the consent form for your records. By signing this document, you consent to participate in the study.

Signature of Participant: ____ Date: ___________________

Signature of Investigator ____ Date: ____________________

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APPENDIX B

STUDENT SELF-ASSESSMENT WEB-PAGE

Clinical Competency Assessment Survey

ASSESSING CHANGES IN COMPETENCY OF FOURTH-YEAR VETERINARY MEDICAL STUDENTS FOLLOWING A DEFINED CLINICAL EXPERIENCE

"A competent individual is one who has adequate cognition, skills, and behaviors to demonstrate appropriate actions in a given setting" (Trent, 2002).

Introduction

Thank you for volunteering to participate in this assessment. Your input will provide valuable information and assistance in the effort to develop an instrument that describes and measures performance of clinical competency in problem solving skills. Confidentiality of student responses is among the highest priorities of this study. All participating student identities and self-assessment score identifiers will be coded to shield against unauthorized viewing. No faculty member will have access or be provided with information linking student identity and self-assessment scores. Furthermore, student self-assessments will have no affect upon nor in any way have influence upon the student's academic grade or future relations with Texas A&M University or employers.

This is the first phase of a multi-phase research design. The intended outcome is to demonstrate intra-rater reliability and statistical correlation between the student and faculty rater. Future development of this assessment tool will be contingent upon the outcomes of this trial.

The rubric is not an exhaustive description or list of skills, attributes or characteristics of clinical competency. The purpose of the rubric is to provide a common standard for measurement and description of competency in problem solving skill. The language used within the rubric is intended to provide a “best fit” categorization of an individual’s current capabilities; it is not intended to be a “scientifically exact” description of the ideal veterinarian. The on-line capability of this survey will enable completion in an asynchronous manner; that is you are not required to start and finish the survey in a single continuous session. The survey may be saved and exited as many times as necessary to allow for other business or personal convenience. It is estimated that the survey can be completed in single 40 minute session if desired.

Instructions

The rubric contained in this Web page lists 12 major headings of competency measurements. Each major heading contains multiple subheadings, referred to as domains, identifying performance standards for a given level of competency. Some competency measures contain as many as six domains while some have as few as three domains. Participants are asked to read across all competency levels and select the domain description that best describes their level of self-assessment. Numeric scores, ranging from 1-12, should then be entered to quantify the competency level that best describes the self-assessment. Each domain competency is scored independently of another. That is, you may score yourself very high in the domain for making an examination during the initial assessment of the patient but follow immediately with a moderate score in the domain for recording patient history. It is acceptable and expected that scores move up and down the scale as each domain is assessed.

Remember that this survey is designed to assess the competency of fourth year, senior, veterinary medical students. Your self-assessment should be referenced in comparison to other fourth year veterinary students you have known or have current knowledge. It would not be correct or desired that you compare yourself or identify with a graduate veterinarian who has acquired years of professional experience. Your classmates are the best and only recommended points of reference for self-assessment comparison.

Helpful Hint

It is recommended that you become familiar with the high and low end descriptions of the competency scale before attempting to self-assess or assign a score for competency within any of the domains. Examine the language used to describe a "Less Than Minimally Competent Student" and compare with the language used to describe "Among The Most Competent Students." Mentally establish a reference as the example of the lowest and highest points of the competency scale prior to attempting to score the midrange levels. Try to become comfortable at the boundaries before attempting to quantify in the middle.

Thank you again for agreeing to participate in this study. Your participation and willingness to record a critical self-assessment are greatly appreciated.

Reference

Trent, A. M. (2002). Outcomes assessment planning: An overview with applications in health sciences. *Journal of Veterinary Medical Education, 29(1),* 9-19.

Simulation of The Problem Solving Process and The Patient

The student's self-assessment should be made with consideration that the rubric was organized to incorporate processes that would be part of the evaluation and treatment plan for a patient animal being presented for the first time at their clinical facility. The assessment of problem solving skills begins with the initial presentation of the animal. The listed order of competencies is for web page organization as much as it is for process. In true life settings, certain competencies conceivably may be completed simultaneously or in different order of priority.

<u>Cognitive Processes</u>

Initial Assessment

Initial Assessment: Obtain oral history

Less Than Minimally Competent Student - generally does not approach the situation or inquire about the problem holistically. Fails to obtain complete and accurate history; does not identify pre-existing conditions.

Minimally Competent Student - becomes detail oriented early in the assessment, has a strong tendency to lose broader situational awareness. Does not ask good questions; is not a good listener.

Fully Competent Student - proceeds systematically obtaining history; identifies pre-existing conditions, searches for relevant information. Asks good questions. Is a good listener.

Among The Most Competent Students -approaches situations broadly, views conditions holistically. Obtains complete and accurate history; identifies pre-existing conditions; asks relevant and detailed questions. Skillfully follows leads.

Initial Assessment: Examination

Less Than Minimally Competent Student - technique lacks thoroughness, is not systematic.

Minimally Competent Student - has not developed or adopted reliable technique for assessing conditions.

Fully Competent Student - has developed reliable technique for assembling information and assessing conditions. Searches for subtleties and secondary conditions.

Among The Most Competent Students - makes thorough systematic examinations; links interrelationships of specific activities. Searches closely for subtleties and underlying clues to the problem.

Initial Assessment: Records

Less Than Minimally Competent Student - does not construct complete and accurate problem list. Does not accurately record information or provide detail.

Minimally Competent Student - is a poor recorder of information, lacks detail and accuracy in note taking.

Fully Competent Student - develops accurate problems list. Maintains detailed notes, constructs accurate records.

Among The Most Competent Students - develops accurate and complete problem list. Maintains detailed notes, constructs accurate records.

Initial Assessment: Accuracy

Less Than Minimally Competent Student - frequently misstates or fails to quantify important facts. Frequently is unprepared to provide current updates.

Minimally Competent Student - has tendency to omit or confuse details. Has been known to embellish or insert opinion in place of facts.

Fully Competent Student - information is routinely reliable and specific in detail.

Among The Most Competent Students - knows to distinguish between observations and opinions. Provides concerned stakeholders with accurate and most recent information available.

Knowledge

Knowledge: Prior Learning

Less Than Minimally Competent Student - memorizes facts but does not synthesize or reassemble facts or prior learning into new knowledge.

Minimally Competent Student - recalls facts but has difficulty reorganizing, reassembling or applying prior learning.

Fully Competent Student -displays strong intellectual skills and cognitive strategies; capably applies prior learning.

Among The Most Competent Students - recalls prior learning with exceptional ability; synthesizes new knowledge from prior learning;

Knowledge: Self-directed Learning

Less Than Minimally Competent Student -requires new knowledge to be provided; does not seek to acquire through individual effort.

Minimally Competent Student - requires guidance in preparation for new learning, does not make effort to engage in self-preparation. Does not anticipate new material, generally does not read ahead.

Fully Competent Student - prepares for new learning; reviews previous course notes, anticipates new material, reads ahead.

Among The Most Competent Students - inquisitive, prepares for new learning, reviews previous course notes, identifies relevant reference materials, reads current literature.

Knowledge: Mastery of Concepts

Less Than Minimally Competent Student - fails to demonstrate understanding of concepts; does not link interrelationships of basic elements presented in the new learning. Generally is unable to explain the concepts to others.

Minimally Competent Student - has difficulty articulating and explaining concepts. Usually does not recognize the interrelationships presented in the new learning.

Fully Competent Student - can articulate and explain concepts; is able to describe the interrelationships of basic components in the new learning.

Among The Most Competent Students - able to demonstrate command of relevant concepts; can effectively link interrelationships of elements contained in the new learning.

Knowledge: Application

Less Than Minimally Competent Student -does not take time or make effort to develop procedural knowledge. Unconcerned about improving ability to apply skills, techniques, or methods.

Minimally Competent Student - has difficulty applying procedural knowledge in skills, techniques or methods.

Fully Competent Student - can demonstrate or apply procedural knowledge in skills, techniques, or methods.

Among The Most Competent Students -capably applies procedural knowledge; skillfully demonstrates appropriate procedures, techniques, or methods.

Analyze Data

Analyze Data: Recognizes interrelationships

Less Than Minimally Competent Student -usually fails to grasp interrelationships present in complex systems, unable or incapable of disassembling information into component parts.

Minimally Competent Student -regularly has difficulty recognizing interrelationships present in complex systems, has difficulty disassembling information into component parts.

Fully Competent Student -demonstrates ability to identify interrelationships present in complex systems and disassemble information into component parts.

Among The Most Competent Students -demonstrates skillful ability to recognize interrelationships present in complex systems and disassemble information into component parts.

Analyze Data: Recognizes trends

Less Than Minimally Competent Student -fails to make comparisons or distinguish changes over time or as a result of conditions. Does not explore emerging patterns or relationships, fails to integrate data and recognize trends.

Minimally Competent Student -does not organize data or make comparisons well; generally requires assistance of others to develop interpretations. Generally fails to recognize or explore emerging patterns.

Fully Competent Student -detects existing patterns, recognizes trends and formulates reasonable assumptions. Accounts for the affects of variables in the interpretation of data. Organizes and compares preliminary results.

Among The Most Competent Students -explores emerging patterns in data; recognizes trends and makes accurate interpretations. Accounts for the effects of variables. Organizes and compares preliminary results

Analyze Data: Validates data

Less Than Minimally Competent Student - does not verify or validate data. Lacks objectivity in interpretations; fails to revise analysis as new data emerges.

Minimally Competent Student -generally requires prompts to verify or validate questionable data. Has difficulty recognizing or interpreting moderate shifts in data sets/reports.

Fully Competent Student - makes appropriate checks of skewed data. Generally recognizes abnormalities or deviations within data set/reports.

Among The Most Competent Students - verifies/validates data. Is quick to recognize shifts in data sets. Makes objective interpretations, restricts inferences to limits of the data. Establishes preset parameters.

Develop Hypothesis

Develop Hypothesis: Theoretical framework

Less Than Minimally Competent Student - generally is not able to articulate scientific principles involved or being used as a point of reference. Does not apply deductive thinking, current knowledge, to future actions or events.

Minimally Competent Student -has difficulty articulating scientific principles involved or being used as a point of reference. Frequently misses or misapplies specific activities associated with the problem.

Fully Competent Student - can articulate the scientific principles involved and being used as a point of reference. Has demonstrated deductive thinking, application of current knowledge, to future events.

Among The Most Competent Students -has mastery and can articulate the scientific principles involved and being used as a point of reference Routinely applies deductive thinking, current knowledge, to future actions or events.

Develop Hypothesis: Acquisition of knowledge

Less Than Minimally Competent Student - generally lacks initiative to conduct review of literature, investigate facts or current status of the research. Overlooks specific activities associated with the problem. Doesn't apply available resources.

Minimally Competent Student - seldom initiates review of literature, investigation of facts or current status of the research. Is hasty to reject alternative courses of action; does not reflect open mindedness.

Fully Competent Student - sometimes initiates literature reviews, investigates current status of the research. Reliably recognizes patterns and makes connections in data and facts.

Among The Most Competent Students - routinely initiates literature reviews, investigates facts and current status of the research. Accurately recognizes patterns and makes connections in data and facts. Consults expert sources.

Develop Hypothesis: Plausibility

Less Than Minimally Competent Student - does not construct tests or describe methods or conditions to disprove predictions or assumptions.

Minimally Competent Student - is not readily accepting of tests, methods or inquiry to disprove selected assumptions or predictions.

Fully Competent Student - asks good questions, is not hesitant to inquire. Constructs test, methods to reveal weaknesses in assumptions and disprove predictions.

Among The Most Competent Students - identifies and accounts for specific activities associated with the problem. Asks well focused and insightful questions. Constructs tests, designs ways to disprove predictions.

Assessing/Assigning Risk

Assessing/Assign Risk: Assesses

Less Than Minimally Competent Student - does not make deliberate assessment of risk factors involved. Fails to consider specific activities of the risk; fails to investigate background conditions that may be associated with the risk.

Minimally Competent Student - inconsistent in taking risk into consideration. Has difficulty recognizing specific activities or conditions associated with the risk.

Fully Competent Student - generally considers obvious risk conditions and assesses possible outcomes. Recognizes specific activities associated with the risk.

Among The Most Competent Students - routinely makes deliberate assessment of the risk factors involved. Considers and accounts for specific activities associated with the risk. Weighs risk to benefit outcomes.

Assessing/Assigning Risk: Analyzes

Less Than Minimally Competent Student - does not disassemble primary variables composing the risk. Does not recognize the secondary conditions contributing to the risk.

Minimally Competent Student - struggles to disassemble multiple variables composing the risk and assessing the contributing relationships.

Fully Competent Student - has some difficulty disassembling the variables composing the risk, and assessing the connecting relationships. Does not always consider or recognize conditions that contribute to the risk.

Among The Most Competent Students - disassembles the variables composing the risk, reassesses the contributing relationships. Investigates the secondary conditions contributing to the risk.

Assessing/Assigning Risk: Estimates risk vs benefit

Less Than Minimally Competent Student - generally fails to include a risk to benefit estimate. Does not make plans to mitigate identified risk.

Minimally Competent Student - has tendency to dismiss risk to benefit consideration. Generally lacks a plan to mitigate identified risk.

Fully Competent Student - carefully considers risk to benefit outcomes. Usually has a plan to mitigate identified risk.

Among The Most Competent Students - diligently tries to quantify/ qualify risk to benefit outcomes. Makes plans to mitigate identified risk. Develops alternative plans.

Making Decisions

Making Decisions: Organizes facts

Less Than Minimally Competent Student - does not demonstrate ability to analyze situations, distinguish discrete variables affecting the problem under consideration.

Minimally Competent Student - tends to struggle as problems increase in complexity. Has difficulty stating the problem accurately or completely; constructs inaccurate problem lists and rule out lists.

Fully Competent Student -accurately analyzes problems and possible underlying causes. Looses accuracy when challenged by complex problems. Logically organizes facts, creates accurate problems list and rule-out list.

Among The Most Competent Students - demonstrates strong skill in analyzing complex problems; identifies underlying contributors to the problem. Assembles and organizes facts in logical order. Creates accurate problem lists and rule-out lists.

Making Decisions: Recognizes secondary outcomes

Less Than Minimally Competent Student - fails to consider relevant facts or examine secondary affects or range of possible outcomes.

Minimally Competent Student -frequently fails to range of possible outcomes. Secondary affects may manifest as a result of oversight or delay in decision making.

Fully Competent Student - is generally aware of secondary affects; applies caution when required. Considers multiple courses of action and plans for alternatives

Among The Most Competent Students -regularly considers and accounts for secondary affects and possible outcomes. Plans for alternate courses of action.

Making Decisions: Seeks & gives input

Less Than Minimally Competent Student - acts unilaterally; generally shuns advice or second opinion.

Minimally Competent Student - tends to seek consensus to justify the selected course of action. Is seldom sought for second opinion by others.

Fully Competent Student - will seek second opinions to verify observations, examine alternatives. Opinion is valued by others and generally welcomed.

Among The Most Competent Students - consults others, welcomes second opinions. Others value and seek her/his opinion.

Making Decisions: Retains objectivity

Less Than Minimally Competent Student - tends to react impulsively, emotions override logic. Constructs unrealistic scenarios to rationalize courses of action.

Minimally Competent Student - generally lacks confidence in analytical ability; has tendency to lose objectivity and react impulsively.

Fully Competent Student - retains objectivity even under stress; is not considered reactionary or impulsive.

Among The Most Competent Students - objectivity is a strength enabling deep insight into problem analysis and decision making. Resists making emotional responses.

Determining Courses of Action

Determining Courses of Action: Able to state objectives

Less Than Minimally Competent Student - does not clearly recognize or attempt to determine succinct goals, objectives, or outcomes. Fails to consider or incorporate prior analysis or results.

Minimally Competent Student - has tendency to proceed before obtaining clear recognition of goals, objectives or expected outcomes. Has tendency to overlook prior analysis or results.

Fully Competent Student - generally seeks to establish clear recognition of goals, objectives or expected outcomes. Usually considers prior analysis and results.

Among The Most Competent Students - constructs or obtains clear statement of goals, objectives or outcomes. Always considers or incorporates prior analysis or results.

Determining Courses of Action: Assesses current situation

Less Than Minimally Competent Student - does not weigh pros vs cons of available courses of action. Frequently fails to consider, sometimes disregards risk potential.

Minimally Competent Student - frequently determines course of action without making close examination of pro vs con. Has difficulty ranking the acceptable courses of action. Generally overlooks consideration of risk factors.

Fully Competent Student - Generally examines pros vs cons of courses of action.. Accepts necessary risk, usually makes plan to mitigate risk.

Among The Most Competent Students - routinely weighs pros vs cons of courses of action; keeps an open mind, attempts to maximize input. Maximizes probability of success with well constructed plans and alternate courses of action.

Determining Courses of Action: Assesses capabilities

Less Than Minimally Competent Student - generally fails to consider personal limits of skill, experience, or equipment required with each possible course. Normally does not consider risk potential prior to initiating action.

Minimally Competent Student - overestimates strengths of skill, experience, or equipment required with each possible course. Has tendency to discount the negative potential of secondary outcomes.

Fully Competent Student - admits to personal limits in skill, experience, or equipment required for each possible course. Recognizes secondary outcomes are possible; usually proceeds with caution when indicated.

Among The Most Competent Students - recognizes and compensates for personal limits in skill, experience, or equipment required for each possible course. Always considers and accounts for secondary outcomes of selected course.

Analyze Results

Analyze Results: Considers the problem

Less Than Minimally Competent Student - does not recognize or consider the problem holistically; frequently fails to recognize information of specific importance relative to the problem.

Minimally Competent Student - generally does not visualize problem holistically. Sometimes loses sight of long term objective; has been known to miss important pathway indicators.

Fully Competent Student -usually examines the problem holistically; applies new knowledge appropriately. Compares results to determine the specific importance of new information.

Among The Most Competent Students - routinely examines the problem holistically and systematically investigates relationships. Separates data and compares new results to determine the specific importance of new information.

Analyze Results: Synthesizes new knowledge

Less Than Minimally Competent Student - does not synthesize new knowledge. Unable to form new hypotheses; fails to test existing hypothesis. Unable to reorganize or construct new relationships using existing knowledge.

Minimally Competent Student - applies results but frequently has difficulty reassembling results and synthesizing new knowledge. Has difficulty formulating new hypotheses.

Fully Competent Student - generally is able to assess results and successfully synthesize new knowledge. Applies results to the existing hypothesis. Is capable of formulating alternate hypotheses.

Among The Most Competent Students - always searches results and synthesizes new knowledge from analysis. Applies results to formulate new hypotheses; applies results to test existing hypothesis.

Analyze Results: Verifies

Less Than Minimally Competent Student - does not examine or apply results to verify that the desired progress in problem solving is being made.

Minimally Competent Student - requires prompting to verify that the desired progress is being made.

Fully Competent Student - observes results and verifies that desired progress is being made.

Among The Most Competent Students - constantly surveys results to verify that the desired progress is being made.

Developing Alternative Courses of Action/Methods

Developing Alternative Courses of Action/Methods: Anticipates need

Less Than Minimally Competent Student - usually doesn't consider secondary outcomes. Fails to assign a risk assessment or make an estimate of the probability of negative outcomes.

Minimally Competent Student - has tendency to overlook or underestimate possibility of secondary outcomes. Tends to miscalculate risk, underestimate possibility of negative outcomes.

Fully Competent Student - considers the primary goals and objectives; constructs plans with anticipation of unexpected outcomes. Considers risk and prepares appropriately.

Among The Most Competent Students - recognizes and considers primary objectives and goals; considers secondary outcomes. Regularly incorporates a risk assessment and estimates probability of negative outcomes with each plan.

Developing Alternative Courses of Action/Methods: Plans appropriately

Less Than Minimally Competent Student - typically reacts to events. Fails to recognize planning as part of the decision making process. Does not identify or recognize implied tasks important to achieving primary objectives.

Minimally Competent Student - generally lacks a plan or fails to prepare to counteract adverse results. Tends to act in haste, reacts as events unfold. Has problems describing implied tasks required to achieve primary objectives.

Fully Competent Student -recognizes need for plans that account for identified risks in decisions. Includes implied tasks into plans.

Among The Most Competent Students - pre-establishes criteria/benchmarks to trigger action. Regularly incorporates planning into the decision making process. Identifies implied tasks important to achieving objectives.

Developing Alternative Courses of Action/Methods: Marks progress

Less Than Minimally Competent Student - unable to identify progress in status change or take advantage of prior experience to gain improvement. Assigns others with responsibility to track progress or signal adverse results.

Minimally Competent Student - Tends to not think ahead or use prior experience to gain advantage. Makes poor decisions based on weak assumptions.

Fully Competent Student - Generally can be counted on to think ahead and use prior experience to gain advantage.

Among The Most Competent Students - Assumes personal responsibility for actions and outcomes; accounts for possibility of unexpected results. Thinks ahead; capitalizes on previous experience of self and others.

Behavioral Processes

The behavioral competencies incorporate the values, social standards, and philosophies that affect judgment and decisions in every part of life. The student is asked to consider if medical decisions and quality of care could be affected by personal belief, bias, or economics.

Responsibility

Responsibility: Leadership

Less Than Minimally Competent Student -avoids leadership responsibility. Unwilling to admit to mistakes or bad decisions; unwilling to take the lead in making difficult decisions.

Minimally Competent Student - follows, but does not assume lead. Is uncomfortable making difficult decisions; complex resolutions tend to overwhelm decision making ability.

Fully Competent Student - will do what is right; can be trusted to take corrective actions when necessary. Willing to make difficult decisions. Willing to admit to mistakes or accept responsibility for bad decisions.

Among The Most Competent Students - automatically assumes lead in taking corrective action, initiating preventive measures. Does not hesitate to admit mistakes or take responsibility for bad decisions.

Responsibility: Selfless service

Less Than Minimally Competent Student - tends to be a self promoter, allows others to bear the burden or make contribution to the needs of others.

Minimally Competent Student - weighs benefits to be received before contributing personal effort or resource.

Fully Competent Student - willingly helps others, acts with compassion.

Among The Most Competent Students - always considers others before self; makes difficult decisions with wellbeing of others in mind.

Responsibility: Character

Less Than Minimally Competent Student - retreats when placed in unpopular positions. Personal values do not represent a high moral standard. Is not trustworthy.

Minimally Competent Student - has tendency to vacillate when faced with moral or ethical problems. Conforms to popular opinion; avoids making individual statement. Has questionable reliability under pressure.

Fully Competent Student - remains loyal to personal values and high moral standards. Is trustworthy and respected.

Among The Most Competent Students - displays moral courage; is role model worthy of emulation. Is unfailingly trustworthy. Is respected by all.

Professionalism

Professionalism: Values

Less Than Minimally Competent Student - are not clearly evident; has tendency to vacillate if pressed on difficult questions.

Minimally Competent Student - not strongly declared; known for selecting the popular position.

Fully Competent Student - clearly evident in personal and professional conduct; does not compromise value system.

Among The Most Competent Students -embraces & demonstrates highest standards in personal and professional values.

Professionalism: Ethics

Less Than Minimally Competent Student - discounts or fails to consider the moral aspect of decisions & judgments.

Minimally Competent Student - sometimes appears to have trouble recognizing the high moral position.

Fully Competent Student - keeps sight of moral considerations affecting decisions & judgments.

Among The Most Competent Students - medical decisions & judgments grounded in moral considerations.

Professionalism: Reflection

Less Than Minimally Competent Student - generally has difficulty explaining clinical thinking or logic applied when assessing problems. Struggles to transfer prior learning to new problems.

Minimally Competent Student -not considered to be a flexible thinker; doesn't self generate concepts and abstractions leading to transfer of learning to solve new problems.

Fully Competent Student - clinical problem solving and logic are capably communicated to others. Recalls and applies prior learning to new problems.

Among The Most Competent Students - is able to explain clinical thinking in assessing problem situations. Effectively transfers prior learning to solve new problems.

Professionalism: Humanitarian qualities

Less Than Minimally Competent Student - not clearly evident or descriptive of behavior.

Minimally Competent Student - assumed to be present; not openly discussed or visibly demonstrated.

Fully Competent Student -reflected in behavior and philosophy.

Among The Most Competent Students - clearly evident in behavior or decision making.

Professionalism: Attitude

Less Than Minimally Competent Student - behavior characterized as pessimistic or negative. Prejudice and bias clearly manifested by lowered quality of professional service.

Minimally Competent Student - is not considered a service oriented individual. Reflects more on the difficulty than on the solution or problem solving. Negative bias tends to be displayed.

Fully Competent Student - positive, seeks solutions, takes proactive measures to prevent disagreement. Does not display negative influences of prejudice or bias.

Among The Most Competent Students - behavior characterized as optimistic and positive; prejudice and bias are not negatively manifested in quality of care or service.

Professionalism: Critical appraisal

Less Than Minimally Competent Student - generally objects to criticism from others. Doesn't provide feedback to others; avoids self-assessment.

Minimally Competent Student - resists offerings of constructive criticism. Tends to be offended if given recommendations for self-improvement.

Fully Competent Student - is accepting of critique, generally tires to accept recommendations of others. Offers constructive feedback to others.

Among The Most Competent Students -accepts criticism from others; provides constructive and accurate feedback to others. Is willing to self-assess.

Interpersonal Skills

Interpersonal skills: Establishes relationships

Less Than Minimally Competent Student -tends to be impersonal or indifferent with others.

Minimally Competent Student -is not oriented to requirements of successful practice; does not identify with the role of service provider.

Fully Competent Student -works diligently to establish a positive relationship with others. Believes in making the first impression a positive event.

Among The Most Competent Students - establishes rapport with clients, colleagues, and staff. Actions are service oriented toward developing successful practice.

Interpersonal skills: Communication skill

Less Than Minimally Competent Student - Ineffective communicator. Interjects personal bias, takes facts out of context etc.

Minimally Competent Student -considered uninspiring; does not instill confidence or trust in the role of a practitioner.

Fully Competent Student -good communication skills; quickly garners confidence and trust.

Among The Most Competent Students - effective communicator; articulates philosophy and values. Inspires confidence and trust.

Interpersonal skills: Empathy

Less Than Minimally Competent Student - behavior reflects low standards of concern & consideration for others.

Minimally Competent Student - appears ambivalent about needs of others; considered a slow responder to requests for assistance.

Fully Competent Student - shows concern for others; is considerate of their needs. Is a ready responder to those in need.

Among The Most Competent Students - identifies with others; is considerate of their needs. Is known to be a first responder to calls for assistance.

Interpersonal skills: Respects others

Less Than Minimally Competent Student - low tolerance for differences in lifestyle or principles of others.

Minimally Competent Student - has tendency to be judgmental. Applies broad generalizations to characterize different lifestyles and principles.

Fully Competent Student - is accepting of others. Does not permit intolerant attitudes of others to affect personal conduct.

Among The Most Competent Students – treat others with respect and accepts differences in lifestyle and principles. Refrains from making negative generalizations about others; challenges intolerant attitudes and behavior of others.

VITA

Noberto Francisco Espitia entered Texas A&M University at the beginning of the fall semester, 1973. He graduated with a Bachelor of Science degree in Biomedical Science in December, 1976. Following graduation, Dr. Espitia was hired as the Clinic Supervisor for the Department of Small Animal Medicine and Surgery in the College of Veterinary Medicine, at Texas A&M University. He has maintained continuous employment in the department since then and can be contacted in the Dept. of Small Animal Clinical Sciences, College Station, TX 77845-4474, or e-mailed directly at nespitia@cvm.tamu.edu.

Dr. Espitia was admitted to Texas A&M University for the second time in January, 1980. He was accepted as a graduate student in the Department of Veterinary Public Health (now named Veterinary Integrative Biosciences) and graduated in December, 1985, with a Master of Science degree in Epidemiology.

In part, because of his professional affiations in veterinary medicine, Dr. Espitia increasingly became involved in promoting and advising educational programs for veterinary technicians in Texas. As a result of interests stimulated by his affiliations, Dr. Espitia applied for admission to Texas A&M Univeristy for the third time.

Dr. Espitia was accepted as a graduate student in January, 2000, in the Department of Agricultural Education. His research emphasis and interest is in educational program development and assessment. Dr. Espitia and his wife, Maria Del Carmen, have been married for 34 years and have two children.