DOCUMENT RESUME

ED 416 756 HE 031 002

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TITLE Enhancing Large-Group Problem-Based Learning in Veterinary Medical Education.
INSTITUTION Kansas State Univ., Manhattan. Dept. of Clinical Sciences.
SPONS AGENCY Fund for the Improvement of Postsecondary Education (ED), Washington, DC.; Pew Charitable Trusts, Philadelphia, PA.
PUB DATE 1995-07-31
NOTE 74p.
CONTRACT P116B1363
PUB TYPE Reports - Descriptive (141)
EDRS PRICE MF01/PC03 Plus Postage.
DESCRIPTORS Case Studies; *Clinical Diagnosis; Clinical Experience; *Computer Assisted Instruction; Higher Education; Large Group Instruction; *Medical Case Histories; Problem Solving; *Veterinary Medical Education; *Videotape Recordings
IDENTIFIERS Kansas State University

ABSTRACT

This project for large-group, problem-based learning at Kansas State University College of Veterinary Medicine developed 47 case-based videotapes that are used to model clinical conditions and also involved veterinary practitioners to formulate true practice cases into student learning opportunities. Problem-oriented, computer-assisted diagnostic programs were also modified to help veterinary students increase their skills in differential diagnosis. The study was also successful in evaluating the neurological problem-space of third-year veterinary students, both in initial groups and subsequently as individuals, distinguishing skilled from novice diagnostic reasoning. The study found that problem-based learning fostered significant advantages and increased student confidence and in-depth learning. Disadvantages included reduced breadth of learning, considerable time requirements, and significant ambiguity. Twelve of the tapes are being used at two other veterinary schools. Sections of the report are devoted to an extensive list of the tapes produced and in production; a bibliography of materials produced by the project, in addition to the project overview, purpose, background and origins, and detailed evaluations and findings. Appendices include "Evaluator Analysis of Interviews" (John Pickrell, Susan Santos, David Balk) undertaken with 35 veterinary medicine students, predominantly in their junior and senior years. (Contains 142 references.) (SW)

Enhancing Large-Group Problem-Based Learning in Veterinary Medical Education

Grantee Organization:

Kansas State University
Department of Clinical Sciences
Comparative Toxicology Laboratories
Manhattan, KS 66506-5606

Grant Number:

P116-B1363

Project Dates:

Starting Date: August 1, 1991
Ending Date: July 31, 1995
Number of Months: 48 (12 month no-cost extension)

Project Director:

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FIPSE Program Officer: Sandra Newkirk

Grant Award:

Year 1	73,610
Year 2	76,245
Year 3	74,256
Total	224,111

ENHANCING LARGE-GROUP PROBLEM-BASED LEARNING IN VETERINARY MEDICAL EDUCATION

Abstract: In this FIPSE project, we extended large group, problem-based learning to validate and begin dissemination of a video-enhanced, practitioner-based, team-oriented approach to case-based veterinary medical education. Forty-seven case-based videotapes were produced and are used to model clinical conditions at KSU College of Veterinary Medicine, increasing student involvement and the quality of their learning. Learning appears greater if oral examination questions are ordered from simple to complex. The neurological problem-space of 3rd year veterinary students was evaluated most successfully in initial groups and subsequently as individuals, distinguishing skilled from novice diagnostic reasoning. Our evaluation team and investigator triangulated findings reveal that PBL fosters significant advantages, increased student confidence and in-depth learning. However, PBL's significant disadvantages, reduced breadth of learning, considerable time requirements, and significant ambiguity while learning are regarded as barriers to introducing PBL curriculum wide in many higher educational institutions.

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PRODUCTS:

Cased-Based Videotapes in Veterinary Medicine and Agriculture:

College of Veterinary Medicine, Manhattan, Kansas, Kansas State University, Supported by Supported by FIPSE, Fund for Improvment of Post Secondary Education, US Department of Education.

*Supported by both FIPSE and HECG (USDA-Higher Education Challenge Grant) Projects (those without asterick * are supported by FIPSE alone).

A. Completed (**available for purchase at $50/videotape; order from project director**)

1992 Fortney W and **Pickrell JA**. Pruritic dermatitis and chronic cough in a dog (Case study).

1992 Lorenz, MD, **Pickrell JA**, Fortney W. Dermatology grand rounds, Willie Perkins (iatrogenic steroids). Both tapes are discussion of a owner-induced case of 7 years duration with dermatology and pneumonic signs.

1992* **Pickrell, JA**. Ammonia and particles in a swine confinement building. Demonstration of measurements and evaluation of indoor air pollution in a swine confinement operation.

1992* **Pickrell, JA**, SR Kerr and S Graff: Dyspneic cows on a weed pasture (pulmonary adenomatosis).

1992* **Pickrell, JA** and Graff S. Dyspnea in cows on a weed pasture. Both tapes discuss cows in a weed pasture are dying with pneumonic symptoms. Owners suspect endotoxin involvement.

1992 **Pickrell, JA**. The clinical toxicology oral examination. Our method of oral examination is shown for the junior class in 1991.

1992 Layton, CE and **Pickrell JA**. Annie (removal of a canine mastocytoma). Surgical technique for removal of a mastocytoma are shown as a surgical problem.

1992 Oehme, FW, Heller T and **Pickrell JA**. What's wrong with my horses, doc?

1992 **Pickrell, JA,** Heller T, Huston L, Gigstead J, and Oehme FW. My horses are lame, what do I do (selenium toxicity)? Both tapes show client explanation, equine symptomatology, poisonous plant identification and short and long term treatments are discussed in the case-based format.

1992 Cowan L, **Pickrell JA** and Kerr SR. An ataxic dog (ethylene glycol). Case-based discussion of an ethylene glycol intoxication. Diagnosis and management are shown.

1992* **Pickrell, JA**, Kerr SR and Epp EL. The case of the wobbly cows (organophosphate insecticide). A puzzling case of CoRal intoxication is presented by the referring veterinarian in the case-based format.

1992 Layton, CE and **Pickrell JA**. Alice, a case of an abdominal mass (removal of a surgical sponge). A valuable opportunity to consider sequelae to in implanted surgical sponge is used in the case-based format.

1992* Beeman, K, **Pickrell JA**, Kerr SR, Kennedy G, and Cimon K. The mysterious case of diarrhea from calves from Dodge City. A presumed arsenic herbicide intoxication is shown in the case-based forat.

1993 **Pickrell, JA** and Kerr SR. Student-centered large group problem-based learning. Our method of teaching toxicology is presented in video with accompanying discussion.

1993 Presnell, T, **Pickrell JA,** Kerr SR, and Fineman L,: A big white weak dog (warfarin toxicity). Clinical features of toxicity, treatment and client education are featured.

1993* Gaughan, E, Kerr SR and **Pickrell JA**. "Show me how you think", demonstrations of clinical decision making. The decision process in equine colics is featured.

1993 Gaughan, K, **Pickrell JA** and Kerr SR. What's shakin? (Pyrethroid [Defend] neurotoxicity in a cat). Clinical features, environmental aspects, and managements are featured.

1993 Gaughan, K, **Pickrell JA,** Stark N, Kerr SR, and Owen T. A cat of a different color (tylenol toxicity). Diagnosis and management of tylenol toxicity are featured.

1993 Gaughan, K, **Pickrell JA** and Kerr SR. What's wrong with this cat: Hemobartonella in a cat. Diagnosis and management of hemoparasitosis in a cat are featured.

1993 Baier, J, **Pickrell JA** and Kerr SR. Leapin Lizards, what happened to Morton: Poor health in a monitor lizard. Poor health in a monitor lizard are discussed in reaching a tenative diagnosis.

1993* Niedtfeld, J, **Pickrell JA** and Kerr SR. If a Bird in the Hand is Worth Two in the Bush. Unexplained deaths in quail used for game are explored. All 3 tapes are shot on the quail and pheasant farm at Solomon, Kansas.

1994* Niedtfeld, J, **Pickrell JA** and Kerr SR. Pheasant blindness. Pheasant blindness presumably from fireweed (*kochia*) intoxication provided as a significant portion of their diet.

1994* Niedtfeld, J, **Pickrell JA** and Kerr SR. This is a game farm; Raising pheasants, chukars and quail for sport. Pheasants raised as game birds are discussed as a vector to immerse prospective exotic practitioners as students.

1994 Morrisey, J, Baier J, **Pickrell JA**, and Kerr SR. Prairie Dog Days: Nervous disorders in prairie dogs. Nervous signs of unknown origin are considered in an effort at proposed management.

1994* McVey, S, **Pickrell JA** and Kerr SR. Salmonellosis in beagle puppies. Experimental salmonellosis in beagle puppies is discussed to introduce the topic to basic bacteriology classes, and as a review in clinical rotation.

1994* Kerr, SR, Anderson NA, **Pickrell JA,** et al. Beef Jerky, Transitory ataxia in a bull. CNS convulsions in a beef bull with encephalomalacia are featured.

1994* Kerr, SR, Anderson NA, Gaughan E, **Pickrell JA**, Leith D, and Schoneweis D. Tracking in Veterinary Medical Education. What's your opinion? Tracking's value and the effect of collaborative (problem-based; case-based) learning are discussed by KSU instructors.

1994 Kerr, SR, Fortney W, Lorenz MD, and **Pickrell JA**. The problem with BJ: Cardiac decompensation in a dog. Cardiac decompensation in this dog features clinical features and response to management.

1994 Kerr, SR, Baier J, **Pickrell JA**. Something Fowl is A foot: Surgical repair of bumblefoot in a raptor. The clinical features of bumblefoot are shown and its effect on the raptor are delineated. Surgical repair of bumblefoot and its response is shown.

1995 Kerr, SR, Lewis DS **and Pickrell JA**. Cerebellar hypoplasia in young puppies **(11 tapes - 8 completed)**. These tapes are conceived to allow students to perform a step-by-step neurologic examination, to compare the findings to those of that examination, to formulate a diagnosis and differential diagnoses and to make management recommendations.

- You are the neurologist, #1 Sadie
- You are the neurologist, #2 Lavendar
- You are the neurologist, #3 Major
- You are the neurologist, #4 Rocky
- You are the neurologist, #5 Zeus
- You are the neurologist, #6 Argus
- You are the neurologist, #7 Toby
- You are the neurologist, #8 Max

1995 Layton CE, Kerr SR, **Pickrell JA**, Foxy, A case of persistent vomiting. Hepatoportal shunt.

1995* Morrissey J, Carpenter J, Kerr SR, **Pickrell JA**, Immobilization techniques and equipment for zoo and wild animals. Optimum clinical restraint of a variety of wild animal species is shown for interns, residents and exotic specialists.

1995* Kerr SR, Morrissey J, J Carpenter, **JA Pickrell** et al., Hold your Tigers, giraffes, zebras and bisons... Restraint in zoo exotic species for students and practitioners.

1995 Gaughan E, Kerr SR, **Pickrell JA**, Surgical repair of the third degree perineal laceration in the mare (June).

1995 Gaughan E, Kerr SR, Pickrell JA, The marred mare (June). Perineal laceration and repair are discussed. The conditions surrounding the problem and the followup care are delineated.

1995* Kerr, SR, **Pickrell JA**, et al. Big Problems—central nervous system disturbance in a hereford bull, possible lightning stroke. The differential diagnoses of central nervous system disturbances in a Hereford bull are related to a brain tumor (July).

1995* Kerr, SR, **Pickrell JA**, et al., Educational impact of videotaped clinical cases. Senior rotational analyses of videotaped cases.

1995* Kerr SR, **Pickrell JA**, et al., Blind bull. The differential of blindness in a bull are discussed and related to this bulls clinical signs.

1995* Kerr SR, **Pickrell JA**, et al., This is a swine farm. Clinical and animal science aspects of different types of swine farms are visually illustrated.

1995 Layton CE, Kerr SR, **Pickrell JA**, et al., A case of a continuous heart murmur. Differential for a persisting heart murmur are discussed and recommendations made.

1995 Carpenter J, Kerr SR, **Pickrell JA**, et al., Inclusion body disease in a python. Includion body disease and associated differential diagnoses and management are discussed for this snake.

B. Editing

1994 Kerr, SR, DS Lewis and **JA Pickrell**. Cerebellar hypoplasia in young puppies (**11 tapes-8 completed/3 in editing**). These tapes are conceived to allow students to perform a step-by-step neurologic examination and to compare the findings to those of that examination.

1994 Fortney, W, **JA Pickrell** and SR Kerr, Demodecosis in a dog. Clinical features outlining the condition are shown.

1994* Schoneweis, D, G Kennedy, SR Kerr, and **JA Pickrell**. Garden-hose gut in swine. Prominent features of necropsy are compared to those of normal swine intestine.

1994 Kraft, SR, **JA Pickrell**, SR Kerr, et al. Digitizing radiologic images are used to demonstrate radiologic examinations.

C. Filming

1994* Stokka, J, **JA Pickrell** and SR Kerr. Respiratory difficulties in young feedlot cattle. Respiratory difficulties of young cattle entering feedlots and on full feed are described.

1994* Gaines, J, **JA Pickrell**, FW Oehme, and SR Kerr. Mastitis in dairy cattle. The atmosphere of a working mid-sized dairy farm is given as a setting for mastitis in that dairy herd.

1994* Brandt, R, **JA Pickrell** and SR Kerr. Grain overload-respiratory difficulties in feedlot steers. Grain overload causing the death of several calves on feed is complicated by significant accompanying respiratory disease.

COMMUNICATIONS:

Published Abstracts:

1991 **Pickrell, JA:** Enhancing large-group problem-based learning in veterinary medical education. Annual Program Directors Meeting Abstracts, Department of Education, Fund for Improvement of Post-Secondary Education, 1991 Program Book (Project Descriptions and Staff Essays, p 84, Washington, D.C.

1992 **Pickrell, JA,** FW Oehme and VL Clegg: Problem-based learning - a tool to enhance toxicology education. Toxicologist 12 (1): 351

1992 **Pickrell, JA:** Enhancing large-group problem-based learning in veterinary medical education. Annual Program Directors Meeting Abstracts, Department of Education, Fund for Improvement of Post-Secondary Education, 1992 Program Book (Project Descriptions and Staff Essays, p 85, Washington, D.C.)

1993 Kerr, SR, **JA Pickrell**, FW Oehme, CL Layton, D Balk, V Primer, VL Clegg, JR Staver, J Galland, WD Fortney, and MD Lorenz: Case-based learning--a tool for involvement, empowerment and evaluation in toxicology. Toxicologist 13(1): 274

1993 **Pickrell, JA:** Enhancing large-group problem-based learning in veterinary medical education. Annual Program Directors Meeting Abstracts, Department of Education, Fund for Improvement of Post-Secondary Education, 1993 Program Book (Project Descriptions and Staff Essays, Washington, D.C.)

1994 **Pickrell, JA**, SR Kerr, FW Oehme, CL Layton, D Balk, V Primer, K McKay, VL Clegg, F Papa, JR Staver, WD Fortney, and MD Lorenz: Case-based learning for validation and professional growth in toxicology. Toxicologist 14(1): 92

1994 **Pickrell, JA,** SR Kerr, FW Oehme, CE Layton, JR Gillespie, DE Balk, V Primer, K McKay, V Clegg, JR Staver, WD Fortney, MD Lorenz, S Gearhart, J Powell: Case-based Learning—A tool for validation and professional growth in veterinary medicine. Proceedings for the XIV PanVet Conference, October 9-14, Acapulco, GRO, MX

1994 **Pickrell, JA**, SR Kerr, FW Oehme, CE Layton, JR Gillespie, DE Balk, V Primer, K McKay, V Clegg, JR Staver, WD Fortney, MD Lorenz, S Gearhart, J Powell: Case-based learning — A tool for validation and professional growth in veterinary medicine. ACVS-AAVC Education Section. Published in the large animal section of Proceedings of ACVS, October 16-19.

Articles-Chapters-Limited Circulation Reports:

1991 **Pickrell, JA:** Problem based learning - a tool to enhance post-collegiate education in Toxicology. Central Society of Toxicology Bulletin. Central States Chapter Society of Toxicology Newletter 6(2):11-14 (invited paper).

1992 **Pickrell, JA:** Progress Report: Problem-based learning to enhance veterinary medical education. FIPSE, Department of Education, Washington, DC, April 15.

1993 **Pickrell, JA**: Progress Report: Problem-based learning to enhance veterinary medical education. FIPSE, Department of Education, Washington, DC, April 15.

Invited Papers-Presentations:

1992 **Pickrell, JA,** FW Oehme and VL Clegg. Problem-based learning - a tool to enhance toxicology education. 31st Society of Toxicology Meeting, Seattle, Washinton, February

1992 **Pickrell, JA,** FW Oehme, CE Layton, VL Clegg, JR Staver, PL Daisey, WD Fortney, MG Shroyer, and MD Lorenz. Problem-Based Learning--A Tool for Involvement, Empowerment and Evaluation in Veterinary Medical Education. Twelfth Veterinary Medical Education Symposium, Iowa State University, Ames, Iowa, June 13-15

1993 Kerr, SR, **JA Pickrell**, FW Oehme, CL Layton, D Balk, V Primer, VL Clegg, JR Staver, J Galland, WD Fortney, and MD Lorenz. Case-based learning--a tool for involvement, empowerment and evaluation in toxicology. Presented at 32nd Society of Toxicology Meeting, New Orleans, Louisiana

1993 Kerr, SR, **JA Pickrell**, FW Oehme, CE Layton, D Balk, VL Clegg, JR Staver, J Galland, WD Fortney, and MD Lorenz. Case-based learning--A tool for involvement, empowerment and evaluation in toxicology. Central States Chapter, Society of Toxicology, Creighton University, Omaha, Nebraska, April 16

1993 **Pickrell, JA**. Enhancing large-group problem-based learning in veterinary medical education. Presented at 1993 FIPSE (Fund for Improvement of Post-Secondary Education) Program Directors Meeting, Washington, DC, October 8-10

1993 **Pickrell, JA:** New adventures in group dynamics. Large-group problem-based learning at Kansas: Successes and barriers to introduction into the curriculum. Presented at 1993 FIPSE (Fund for Improvement of Post-Secondary Education) Program Directors Meeting, Washington, DC, October 8-10

1993 **Pickrell, JA** (Moderator). New adventures in group dynamics. Collaborative learning in the medical sciences and higher education. Presented at 1993 FIPSE (Fund for Improvement of Post-Secondary Education) Program Directors Meeting, Washington, DC, October 8-10

1993 **Pickrell, JA** (Principal Investigator, Coordinator). Site Visit: Problem-based learning in Veterinary Medical Education. United States Department of Education, Fund for Improvement of Secondary Education (FIPSE), Dr. Sandra Newkirk, Site Visitor, FIPSE, Washington, DC

1994 **Pickrell, JA**, SR Kerr, FW Oehme, CL Layton, D Balk, V Primer, K McKay, VL Clegg, F Papa, JR Staver, WD Fortney, and MD Lorenz. Case-based learning for validation and professional growth in toxicology. Presented at Society of Toxicology, Dallas, Texas, March

1994 **Pickrell, JA,** SR Kerr, FW Oehme, CE Layton, JR Gillespie, DE Balk, V Primer, K McKay, V Clegg, JR Staver, WD Fortney, MD Lorenz, S Gearhart, and J Powell. Case-based Learning—A tool for validation and professional growth in veterinary medicine. Proceedings for the XIV PanVet Conference, October 9-14

1994 **Pickrell, JA,** SR Kerr, FW Oehme, CE Layton, JR Gillespie, DE Balk, V Primer, K McKay, V Clegg, JR Staver, WD Fortney, MD Lorenz, S Gearhart, and J Powell. Case-based Learning—videotaped illustrations. Proceedings for the XIV PanVet Conference, October 9-14

1994 **Pickrell, JA**, SR Kerr, FW Oehme, CE Layton, JR Gillespie, DE Balk, V Primer, K McKay, V Clegg, JR Staver, WD Fortney, MD Lorenz, S Gearhart, and J Powell. Case-based learning—A tool for validation and professional growth in veterinary medicine. ACVS-AAVC Education Section. Large animal section of Proceedings of ACVS, October 16-19

1995 **Pickrell, JA**, SR Kerr, FW Oehme, CE Layton, JR Gillespie, DE Balk, V Primer, K McKay, V Clegg, JR Staver, WD Fortney, MD Lorenz, S Gearhart, and J Powell. Case-based learning—A tool for validation and professional growth in veterinary medicine. Problem-Based Learning in Veterinary Medicine, San Diego, CA, March 4-7.

Preliminary In-House and Regional Presentations

1989 KSU/College of Veterinary Medicine "First Friday Lunches" *Problem-Based Learning Experiences in KSU the Veterinary College* (**JA Pickrell,** B Fenwick, W Cash, DTroyer), Manhattan, KS, December (attendance $\geq$ 40 faculty);

1990 KCRCHE Teaching Effectiveness Conference, Rockhurst College, Kansas City, KS, February) LG-PBL: *The early experiences in Veterinary Medicine* (attendance $\geq$ 150 faculty)(**JA Pickrell**, W Cash, D Troyer).

1990 Graduate course EDCI 843, *Principles of College Teaching, LG-PBL in the veterinary toxicology classroom,* Kansas State University, Manhattan, KS; April (**JA Pickrell**, attendance $\geq$ 10 potential faculty).

1990 Master Teachers Conference, *Case-based learning in the professional curricula,* St. Mary's College, Leavenworth, KS; June (attendance $\geq$ 25 faculty)(**JA Pickrell**).

1990 KSU/College of Veterinary Medicine "First Friday Lunches", *SG-PBL in Veterinary Pathology: an experiment,* Manhattan, KS, August (attendance $\geq$ 40 faculty)(R Oberst);

1990 KSU/College of Veterinary Medicine "First Friday Lunches", *Cooperative learning: the best approach?* Manhattan, KS, December (attendance $\geq$ 40 faculty)(B Fenwick);

1991 KSU/College of Veterinary Medicine "First Friday Lunches", *LG-PBL in Veterinary Clinical Toxicology: the first 2 years,* Manhattan, KS, April (projected attendance 40 faculty)(**JA Pickrell**, FW Oehme)

ENHANCING LARGE-GROUP PROBLEM-BASED LEARNING IN VETERINARY MEDICAL EDUCATION

Grantee Organization: Kansas State University; Department of Clinical Sciences
Comparative Toxicology Laboratories; Manhattan, KS 66506-5606

Project Director: John A. Pickrell

Telephone (913)-532-4331 [Fax (913)-532-4481; E-mail Pickrell@vet.ksu.edu]

EXECUTIVE SUMMARY: Project Overview: Real-life questions were being posed to junior veterinary students in a Toxicology class in the College of Veterinary Medicine at Kansas State University (KSU) to initiate discussion of diagnosis and management of "their cases." These students are part of a growing number who learn by analyzing practice cases. In this project, we extended this learning to validate and begin dissemination of a video-enhanced, practitioner-based, team-oriented approach to case-based veterinary medical education. During this project we produced 48 case-based videotapes (3 more filming or 6 in production) and a small animal and a ruminant neurologic diagnostic matrix. We tested and evaluated the small animal diagnostic matrix. We find that the tapes were memorable when used in class, as indicated by student comments to instructors and on anonmyous surveys. Twelve of these tapes are being used to instruct veterinary classes at veterinary schools at the University of Texas and the Atlantic Veterinary College on Prince Edward Island, Canada. We believe the tapes have their greatest utility as review tools when senior students model clinical conditions during their senior clinical rotations. KBIT estimated student small animal neurologic knowledge bases in both groups and individuals. Group interactions and added time for integration allowed students to bolster their perceived weaknesses more effectively than did individual study.

Purpose: We enhanced large-group problem-based learning (LG-PBL) to improve student learning by 1) developing cases into case-based videotapes and by involving veterinary practitioners to formulate true practice cases into student learning opportunities and by 2) Modifying problem-oriented, computer-assisted diagnostic programs so that veterinary students could enhance their skills in differential diagnoses.

Background and Origins: Ideas for this project began to evolve better methods of teaching and learning for the 21st century, encouraged by the Pew Trust, discussing the possibility that learning could most effectively take place in the context in which it would later be used. Our faculty team interested in case-based learning was assisted by adaptation of Dr. Frank Papa's (TX College of Osteopathic Medicine) knowledge bit information (KBIT) computer system for assessing student knowledge bases for veterinary medical diagnoses.

In adopting LG-PBL as our teaching strategy, it was our intention to change student learning strategies from memorization to learning throughout their professional careers. LG-PBL requires that students actively work toward the understanding or resolution of specific problems. In working with the problems, "students are expected to draw on previous learning and experience, to pose questions concerning new issues, to set personal learning goals, to take responsibility for their own learning through independent reading and study, and to teach one another with student-to-student discussion" (141).

Project Descriptions We enhanced LG-PBL by:

1. Developing the case-based practitioner-assisted videotapes to formulate true practice cases into student learning opportunities.

2. Modifying existing problem-oriented computer-assisted diagnostic programs (KBIT software) to enhance student differential diagnostic skills.

To accomplish these objectives, we validated 47 case-based videotapes, and canine and ruminant KBIT analyses of neurotoxicant space. We disseminated our learning system throughout our college and into two other North American Veterinary Colleges. Academicians from Mexico, Brazil and other Pan American Veterinary Colleges expressed interest in the possibility of translating our case-based scenarios which apply to their unique areas. Visually enhanced stories were filmed and produced as case-based videotapes. These tapes were used as the framework for advanced learning in junior clinical toxicology and mentoring clinical toxicologic medicine during senior rotations. Groups improved student involvement and intragroup cooperation. Students began to validate their accomplishments by testing their knowledge bases against KBIT following their experience as junior groups and by answering randomly drawn "quiz-bowl" types of questions on their senior rotations. Transition to limited-temporary expertise was quantifiable and dependent upon previous experience as indicated on oral examination. This fall we used both group and individual questions to obtain group improvements in treatment, diagnostic reasoning and ability to explain mechanisms, the beginning of expertise. One month later, the group experience was associated with slightly higher scores on examinations similar to that given 1.5 weeks earlier. In addition, the group experience was associated with more treatment completeness and greater depth of explanations of mechanisms, suggesting further steps to expertise.

Evaluation/Project Results: Students find the case-based videotapes of considerable use in class for introduction and modeling to that clinical condition as indicated by unsolicited comments following their presentations and comments on surveys. In addition, they find them of considerable use for reviewing during their clinical rotations. Many have indicated interest in purchasing new tapes in practice, as have practitioners at annual conference and veterinarians from Mexico, Brazil and other panAmerican countries (translation needed). They make productive suggestions for improvement of tapes and find they present a clear model of the signs—almost like a case. Faculty who use these tapes believe that such models go beyond word paper descriptions, but fall short of an excellent clinical case, where all the senses may be used for diagnostic reasoning. These tapes allow the case to be reviewed until concepts are clear.

Teaching partners, a partnership between CE Layton and JA Pickrell in which we visited each others classes 3 times and interviewed 3 students each, making and soliciting formative comments to improve teaching, revealed a bias toward action (hands-on experience), increasing use of groups for consultation, appreciation of the instructor support provided by these teaching partners, and a preference for individual oral examinations, especially those exainations with questions of ordered difficulty.

During the second project year D Balk's evaluative team confirmed widely held college beliefs and college issues about problem based learning (PBL). Both strengths and potential problems of PBL were those reported in the PBL literature. **Widespsread beliefs) confirmed by interviews** were: 1) PBL takes a lot of time; 2) Ambiguity is inherent in PBL; 3) Facilitators are the key to student success in small-group PBL; and 4) Learning the problem-solving process is a goal of PBL. **Issues confirmed dividing faculty, students and practitioners** were: 1) Combining lectures and PBL would be more effective either separately;

2) PBL builds student confidence; 3) PBL increases retention of information; and 4) PBL allows in-depth learning at the expense of breadth of coverage.

Evaluation of the 3rd year Clinical Toxicology students conducted during the 2nd and 3rd project years indicated partial validation of these objectives (investigator comments in italics) 1)Faculty provided a structure which will allow students to integrate what they have learned and enhance student transition to temporary experts; students resisted this structure; 2) Faculty provided exams fostering an instructor-dependent colleague to colleague relationship to facilitate learning; 3) Faculty developed tests which reflected student abilities; 4) Students only partially changed learning strategies from memorization to lifelong learning; 5) Education was initially direct; as demands in other courses increased learning became passive.

Case studies of 3rd year veterinary students conducted during the 3rd and 4th project years revealed that: 1) Students are given large amounts of information causing them to fall behind; 2) Student's lives reflect their scheduled hourly tests for the week; 3) Students use their spare time to do things that they enjoy; 4) Students consider an A or a B an acceptable grade; 5) Groups support individual members, serving an important function in the lives of veterinary students; 6) The 3rd professional year marks the transition between the first 2 years of basic science and the 4th clinical year just preceeding students entry into their practice life; 7) The main concern of 3rd year professional students is preparation for the 4th year; 8) Students do not believe the national board is an effective method of testing their skills as practicing veterinarians; 9) Students showed signs of burnout during their 3rd professional year; 10) Students respect faculty who treat them with courtesy (willing to help outside of class, grade exams promptly, treat them like professional colleagues) and who have significant practical experience (knowledgeable, provide practical information in a way that they can understand).

During our 4th project year, our team of evaluators and investigators validated the following hypotheses: Case-based videotapes *Hypotheses 1 and 2)* **Practitioner-generated cases and case-based videotapes increased student involvement** as estimated by instructor, observer and by videotapes; *Hypothesis 3)* **Case-based learning increased the incidence of practitioner quality answers** on oral examinations; *Hypothesis 7)* **At least 80% of the students did not take credit for transition from novice to limited pre-expert**; only **10-60%** did, and that with difficulty; KBIT profiles: *Hypotheses 4 and 5)* **KBIT profiles of the neurotoxicant problem space in small animals could distinguish mastery levels of diagnostic skills from low levels of diagnostic skills**. Students more easily identified areas which needed work, and had more difficulty taking credit for their achievements. *Hypothesis 6*, **students with high diagnostic efficacy would have a different diagnostic path** was not testable by KBIT.

Summary and Conclusions: Forty-seven case-based videotapes were produced and are used to model clinical conditions at KSU College of Veterinary Medicine, increasing student involvement and the quality of their learning. Learning appears greater if oral examination questions are ordered from simple to complex. The neurological problem-space of 3rd year veterinary students was evaluated most successfully in initial groups and subsequently as individuals, distinguishing skilled from novice diagnostic reasoning. Our evaluation team and investigator triangulated findings reveal that PBL fosters significant advantages, increased student confidence and in-depth learning. However, PBL's significant disadvantages, reduced breadth of learning, considerable time requirements, and significant ambiguity while learning are regarded as barriers to introducing PBL curriculum wide in many higher educational institutions.

ENHANCING LARGE-GROUP PROBLEM-BASED LEARNING IN VETERINARY MEDICAL EDUCATION

Project Overview

Real-life questions were posed to junior veterinary students in a Toxicology class in the College of Veterinary Medicine at Kansas State University (KSU) to initiate discussion of diagnosis and management of "their cases." These students were part of a growing number who learn by analyzing practice cases. In this project, we extended this learning to validate and begin dissemination of a video-enhanced, practitioner-based, team-oriented approach to case-based veterinary medical education.

At KSU, this form of learning began as part of a self examination and partial solution of the ever increasing information required to be learned as part of today's education to become a veterinarian and to practice Veterinary Medicine. College-wide, faculty members intensely discussed the possibility that learning could be enhanced by obtaining essential facts in the context that they would be encountered in veterinary practice. Our project proposed to extend this concept by using practitioner cases to place learning in the context of veterinary practice. Using videos of clinical signs to model specific important clinical veterinary diseases. This approach was inspired by watching instructors act out clinical signs in a story-telling form and subsequent discussions with them. On a routine literature search, JAP discovered an interesting use of a computer program where clinical signs and potential diagnoses were cross-compared to assess students ability to differentiate and subsequently model clinical conditions. Subsequent discussions with Dr. Frank Papa (TX Coll Osteopathic Medicine, Ft Worth, TX; FIPSE project 2-time awardee) suggested that we could adapt his work to Veterinary Medical situations so that enhanced student knowledge bases could be evaluated.

These teaching interactions at KSU initially involved eight faculty who have used case-based learning in a variety of different ways. They report heightened student interest and enhanced learning. Our administration strongly supported this revolution. Our numbers had grown from one faculty member during the spring of 1989 to nearly fifteen faculty members having an interest in problem-based learning (PBL) less than two years later.

During this project we produced 47 case-based videotapes, a small animal and a ruminant neurologic diagnostic matrix. We tested and evaluated the small animal diagnostic matrix. We find that the tapes were memorable when used in class, as indicated by student comments to instructors and on anonymous surveys. Twelve of these tapes are being used to instruct veterinary classes at veterinary schools at the University of Texas and the Atlantic Veterinary College on Prince Edward Island, Canada. We believe that the tapes have their greatest utility as review tools when senior students model diseases during their clinical rotations. KBIT estimated student small animal neurologic knowledge bases in both groups and individuals. Group interactions and added time for integration allowed students to bolster their perceived weaknesses more effectively than did individual study.

Purpose

We concluded that we could enhance student learning with large group problem based learning (LG-PBL) by:

1. Investing considerable energy in developing the cases and case-based videotapes which are at the heart of LG-PBL by involving veterinary practitioners to formulate true practice cases into student learning opportunities.
2. Modifying the existing problem-oriented, computer-assisted diagnostic program KBIT to enable students to enhance their skills in differential diagnoses in school and practice.

Background and Origins

"Doctor, what are you going to do for the cows which are down and gasping?" This question could have been asked of any large animal veterinarian practicing in almost any english speaking country anywhere in the world. Instead, it was posed to junior veterinary students in a Toxicology class in order to initiate a discussion of the diagnosis and management of "their case." These students in the College of Veterinary Medicine at Kansas State University (KSU) are part of a growing number who learn via Large-Group Problem-Based Learning as they analyze real-life cases.

Initially, our students had enthusiasm as indicated by their covering most of the assigned readings, and come to class ready for "their case." A higher percentage of students are actively involved in learning during the Toxicology classes. People visited our classes to watch PBL "in action". In addition, a toxicologist at another university has asked to trade cases. Our students recommended the evaluation system used in a case-based course, Clinical Toxicology and Surgery, because they felt that the exams were effective and accurate evaluations of their ability, a learning experience that allowed them to integrate their knowledge to that point.

In the December 1990, mid-year veterinary medicine juniors were surveyed in order to obtain comparative data for faculty who are working to improve the testing procedures for first-year students in the College. Juniors were asked for their reactions to the testing procedures they had experienced during the previous fall semester. Specifically, they were asked to explain "What changes would you suggest to make testing procedures more effective in helping you learn and in evaluating what you know." The survey did not mention either case-based or problem-based learning. Nevertheless, 20 of the respondents suggested that examinations similar to those we were using to assess learning in LG-PBL in Toxicology and Surgery be initiated. Their answers revealed why they made these suggestions. They felt that exams were effective and accurate evaluations of their ability, that they were a learning experience, and that oral exams allowed them to integrate their knowledge to that point. These answers are noteworthy for three reasons: 1) students usually express disaffection, not affection for tests; 2) this was the only positive solution proposed consistently for the problems students saw with the testing procedures; and 3) they chose problem-solving as the best way to test themselves for performance in clinical decision making, an activity in which they presumably viewed themselves as totally immersed by this stage in their careers.

LARGE-GROUP PROBLEM-BASED LEARNING (findings, from this project, germane to this review are noted in italics:

In adopting **Large Group Problem Based Learning (LG-PBL)** as our teaching strategy, it was our intention to change student learning strategies from memorization to a style more conducive to learning throughout their professional careers, *in retrospect, we were at least partially successful in accomplishing this goal.* LG-PBL requires that students actively work

toward the understanding or resolution of specific problems. In working with the problems, "students are expected to draw on previous learning and experience, to pose questions concerning new issues, to set personal learning goals, to take responsibility for their own learning through independent reading and study, and to teach one another through student-to-student discussion" (141). *In our experiences, students took this responsibility reluctantly.* Initially, our administration strongly supported this teaching revolution as part of a continuing desire to improve veterinary education at KSU.

We believe that LG-PBL is an improvement over more traditional memory-based classroom teaching strategies because LG-PBL allows students to practice solving problems in the context in which the knowledge is to be used (2, 13, 58, 65, 100, 101, 141). LG-PBL speeds incorporating facts into clinical procedures, and the emergency procedures learned become almost automatic (10-12, 26, 33, 58). As Mark Twain said, "A person who has had a bull by the tail once has learned 60 or 70 times as much as a person who hasn't" (132).

Problem-based learning engages students by requiring that they actively work toward the understanding or resolution of specific problems. In working with the problems "students are expected to draw on previous learning and experience, to pose questions concerning new issues, to set personal learning goals, to take responsibility for their own learning through independent reading and study, and to teach one another through student-to-student discussion" (141).

Problem-based learning is interactive and student-centered. It focuses attention on student learning, not teaching (10-15, 33, 34-38, 52, 56, 58-71, 86-115, 125-135, 140-141). The case is a form of storytelling (75, 102, 142) which focuses directly on a practice situation and leads to increased student-student-faculty interactions, discussions, cooperation and learning (10-12, 15, 29, 33, 34-36, 44-45, 47, 57- 59, 70, 101, 141). As in most good schools, involvement, intensity and focus of both students and teachers raises the quality of their profession (14, 32, 107). *Although students do not enjoy the ambiguity inherent in PBL, especially ambiguity under pressure,* they learn to enjoy the mystery of the diagnosis (83), and through instructor guidance find their future (80).

Problem-based learning is frequently used to teach higher-order cognitive, affective and psychomotor skills (10-12, 34, 44, 56, 60-61); for example, cases provide a close link to field experiments, teaching cognitive analysis and evaluation, affective valuing—organization, and psychomotor adaptation. The teaching orientation using this method is student-centered. In this approach, elements of both student-centered cognitive learning styles and student-centered affective learning styles are modeled. Problem-based learning focuses on use of context and intuition and facilitates student learning to the point that students can visualize themselves effectively making correct diagnoses *and validate* these diagnoses. While the students haven't yet become experts, they are close enough to have confidence that they will eventually achieve an acceptable level of diagnostic skill. Experiencing this "pre-expert role" dramatically influences professional and post-college education as well as patient healing (13, 51, 55, 57, 63, 68, 91, 100, 106, 119, 126). *In our experience, as students mature, they develop the patience under pressure to begin to validate their diagnoses during their clinical year. PBL teaches them patience with some difficulty.*

Analysis of a case situation "fixes" the facts by making connections to other similar data bases (13, 23, 29, 31, 36, 52, 56, 93, 65, 128, 138) and defining a specific disease (definers). The connections and the recall of these facts adds analytical depth, encouraging the novice to abandon surface problem-solving strategies in favor of the deeper expert strategies (108, 117) and leading to increased present and later performance (34). *Expert problem solving strategies collect, encapsulate, transform, retain, quantitatively explain and refine diagnostic*

hypotheses, going beyond marginal solutions to solve everyday practice problems (74a, 85a, 126a, 133a).

Factors conveying the ability to discriminate one disease from other similar ones (discriminators) are a function of specific domain knowledge and experience, and may be the limiting factor to novice-intermediate clinical performance (22, 69, 95, 96, 97). There are five common reasons for diagnostic-therapeutic errors (137): **1.** Insufficient data gathered; **2.** Inadequate hypotheses generated; **3.** Inattention-misinterpretation of differentiating cues; **4.** Delayed or missed diagnoses; **5.** Inappropriate-mismanaged-delayed therapy. LG-PBL seeks to reverse limitations #1 - #3. *Our experience suggests that sign frequency and descriptions, monitored by KBIT analyses relate specifically to 2-4. Expertise may relate to ability to analyze cases of increasing atypicality and arrive at correct diagnoses.*

In cooperative learning, students take responsibility for their own learning and support each other, much as mentors would (68). Teams or groups promote student involvement and active, student-centered, cognitive and affective learning. Since most learning in real-life is cooperative, students beginning early in elementary school have used this technique to maximize their learning. This technique is problem-driven, and problems can come from all walks of life, allowing students to model future potential occupations while learning (68). Beginning groups function best as pairs or triads. Even accomplished student groups will seldom be productive with more than 7-8 members. Many classrooms in which cooperative learning is practiced have 18-25 students, but some may range as high as 150+ students.

Commonly, a small group of 5-7 students practice problem-based learning with a faculty adviser. This teaching approach generates the most student-student interaction. It does expose students to the most faculty and their different teaching styles; however, it is extraordinarily faculty intensive (teacher/student $\geq$ 1.4;) and is made more so by relying on additional faculty experts. *Our experience suggests that groups of 5-6 students, mildly challenged, or groups of 5-6 taking typical case-based examinations work together better than groups of 3-4 3rd year veterinary students.*

Problem-based learning can also be practiced in large groups of 30 to 150 with a single expert faculty discussion leader. This Large-Group Problem-Based Learning generates more student-student interaction than does lecture-discussion. The faculty discussion leaders in LG-PBL provide a student-centered affective component to learning. Finally, this application of problem-based learning is less faculty-intensive, making it possible to accomplish with the present size of almost all veterinary faculties (teacher/student $\leq$ 0.25 at KSU). *Our experience suggests that LGPBL has inherently higher ambiguity levels and requires more summary than does small group problem based learning. This method provides no intragroup working important to the success of SGPBL.*

Periodically breaking this large group into several smaller groups is believed to make the student-centered, cognitive learning experience more like that of problem-based learning with smaller groups by generating relatively higher amounts of student-student interaction. This unusual combination of LG-PBL and cooperative learning makes learning more dependent upon student involvement, and less dependent upon the individual teacher's pedagogical technique.

Even though almost nothing is known about how information can be extracted from pictures (71, 79-84), **word pictures or actual illustrations appear to magnify the strength of problem-based learning** (23). We know from experience that information is recalled from mental pictures as needed, and that it is never even a small fraction of the total richness and context of information that the original picture carried (116). The use of stories presented by the practitioner cases on videotape enhanced student learning.

Increased enjoyment of learning for both students and teachers through the strategies of problem-based learning leads to a desire to continue learning beyond college (115, 116, 125, 131-141), often throughout the professional's life.

Project Descriptions

Our project noted 2 LG-PBL enhancements to significantly improve student learning:

1. Selecting and developing the cases which are central to learning by LG-PBL by involving veterinary practitioners in formulating true practice cases into student learning opportunities.
2. Modifying existing problem-oriented, computer-assisted diagnostic programs to allow student multiple trials, thereby enhancing formulation of lists of likely diagnoses, the differentiation of likely diagnoses, and further description of the professional's model (vision) of the specific disease in school and later in practice.

1. **Visual informational extension of LG-PBL provided greater details defining disease models and discriminating such diseases from similar neurological diseases.** We brought practitioner-assisted cases to the veterinary medicine classroom as case-based videotapes. Context and practice stimulate problem-based learning (2, 58, 65, 141), actual practitioner cases improve context. Papa's (94) demonstrated that the richness of the real case will increase involvement in the case and empowerment to suggest diagnostic hypotheses and management procedures. KSU's mixture of small animal practices in the Kansas City, Wichita, and Topeka metropolitan areas and their large base of beef production (74) allowed us to draw cases can be drawn from veterinarians already practicing problem-oriented small animal medicine (46) and from those clinicians practicing the more traditional system/disease-oriented, prevention-based beef production medicine at the nation's center of production medicine.

We documented 47 cases to make case-based videotapes. Initially, Toxicology Professors Oehme and Pickrell identified the most promising toxicology and medicine cases from the more than 5,000 telephone consultations and the 1,100-1,500 toxicological analyses relayed annually. Cases from our intensive care unit were identified for student learning (SG-PBL, LG-PBL, oral examinations, educational issues) community medicine, internal medicine, exotic medicine (prairie dogs, snakes, hawks, quail), equine medicine, food animal medicine, bacteriology-immunology, radiology-anatomy-internal medicine neurology and soft tissue surgery. We solicited practitioners' most puzzling cases through requests and by *word of mouth* at the time of telephone consultations. This collaboration provided richer cases, and led to closer working relationships with our already supportive alumni, fostered by investigator membership in committees, committee chairs and officers of the KVMA and in one case the AVMA. Once an initial potential case was identified, the most promising cases were be further screened. Selection of cases will depend upon teaching value: 1) relevance (frequency), 2) completeness (amount of diagnosis-management puzzle present), 3) defining and differentiating features; 4) diagnostic accuracy; and 5) management appropriateness and timeliness.

The case-based videotapes were documented by videotaped personal interviews in the veterinarians' or owners' practice location. These videotapes provided a wealth of contextual detail. Such detail was useful in formulating the case. In addition, the details of clinical signs from both discussion and illustration was documented clearly. *Students analyzing these cases found initial modeling of the case and review of that modeling in their senior rotations to be of great value.* Direct interviews of practitioner or faculty illustrated these advantages.

- Face to face practitioner, faculty and some client contact added immensely to the case, exceeding information of the initial telephone interviews because the limited verbal communication possible by telephone accounts for only about 15% of the total communication possible between two individuals talking face-to-face.
- Practitioners and faculty set time aside for people for the important discussions of their cases.
- Clinical details arose from the interaction of two consulting practitioners, just as they do in problem-based learning and in life.
- Practitioners and faculty remembered important details regarding their cases much better when they were in their own environment.
- Interviewing on site will bring the faculty member/interviewer back into the practice site, thus improving the interviewer's appreciation for and understanding of the setting for the case.

Next, the coinvestigators and the post-doctoral fellow prepared LG-PBL cases from the information and videotaped interviews. Selection of the relevant detail from the case was a consensus of the case writer, the practitioner or faculty member, and an expert in that field. This knowledge was combined with knowledge relating to comprehension in a narrative-case-story-practice situation (23), and to the pattern and context of that case (87, 116). We will provide defining and discriminating clues in a wealth of contextual detail derived from practice. This detail made the case *hang together* more completely, and suggested means for the student to organize the essential detail, progressing from storytelling to defining, discriminating and finally integrating with conceptual detail (87, 116). We monitored the increase in knowledge gained from videotapes relative to that from case analysis at oral examination.

Following these decisions, the videotapes were edited for classroom use by the staff of the Audio-Visual Resources Center (AVRC) who provide comprehensive AV services to the College of Veterinary Medicine and to other requestors. When the case is first presented in the classroom, the practicing veterinarian or faculty member was invited to participate.
Under the scrutiny of 90 intensely-focused veterinary students, facts and issues will emerge that sharpened and clarified the case and improved its usefulness as a teaching tool. Senior (4th year) veterinary students made suggestions for improvements which were implemented. This videotape was edited by consultation between the same team (practitioner, interviewer and faculty specialist) and revisions incorporated into the case-based videotape.

2. **When our veterinary medical students use the special version of KBIT developed by Papa for this project,** they selected the most relevant primary complaint, small animal or ruminant neurotoxicology. The students designated the relative frequency of that complaint (variable), looked at **indicators-times of risk** (in our example, lead from batteries, rodenticides, enterotoxemia/food poisoning), as well as modifiers of this primary complaint such as **onset** (when did it happen...minutes to several days ago), **duration** (it is a continuing condition), and **intensity** (high). Finally, the students looked for correlation with subordinate signs, perhaps respiratory signs associated with progressing shock, and secondary association of the liver with both shock and dehydration. When the students entered everything they know about the disease-symptoms and their relative incidence, they indicate that they have finished. This process was referred to as "fitting characteristics of their knowledge base to their differential diagnostic protocol."

The KBIT computer program compared the students diagnostic protocol against the case battery, indicated the number of cases in that battery that the student would have diagnosed correctly *and indicated what the incorrect diagnoses had been.* A score is reported as percent correct for each potential diagnosis. Then the students modified their diagnostic protocol, reran

the program and immediately note improvements. The KBIT computer program was not able to keep running track of changes in their diagnostic protocol and changes in their score. This audit capability was not able to be installed as a new feature of the KBIT software program. *In our experience, students were much more able to identify diagnostic deficiencies than to pinpoint them specifically. This made it difficult for students to take credit for their achievements unless they were already quite good diagnosticians. Our best progress was with students who had tried this program initially as juniors in groups and then subsequently as individuals. Preliminarily, this fall, we have verified the same enthusiasm from senior groups taking it for the first time. They inform us that they expect to try it as individuals in the near future.*

LG-PBL students used KBIT in teams to develop clinical decision making strategies. Subsequently individual students practiced with this software after hours to sharpen their diagnostic skill prior to their next evaluation. To date, such analyses have not yet been made a part of our student evaluations, because of the pronounced underestimation of diagnostic efficacy in novices and intermediate diagnosticians. *F Papa (TX Coll Osteopathic Med) and JA Pickrell (KSU) continue to consult about using this as an evaluation of group testing, and against case atypicality to evaluate student knowledge bases (36-38, 64, 93-95, 118).*

We adapted Papa's KBIT software for use in the veterinary medical classrooms to improve student diagnostic skills. F Papa and his computer programmer modified the KBIT software to our specifications. *To date, in spite of investigator discussions, only minimal interest has been demonstrated for this in practice situations.*

Dr. Papa joined us in Manhattan to conduct initial introductions; we were able to join him in Forth Worth, TX; we consulted frequently by phone. We initiated protocols to investigate neurotoxicant problem space in small animals and ruminants, and are continuing this process. We most extensively tested evaluations of small animal neurologic space, reflecting the fact that 75%+ of our students will work in small animal medicine, and the commonality of neurotoxicant problems. Results from these processes:

- Defined group student knowledge bases for the common small animal neurotoxicant diagnoses.
- Allowed students to consult about her/his data base to one more successful (diagnosing a higher fraction of cases in that battery).
- Experientially partially taught students to define a knowledge base. *Less proficient diagnosticians identified so many potential problems that they had trouble progressing. Encouraging them to work in groups seemed to "prime the pump" sufficiently to get them started. After reaching a high plateau of diagnostic skill they were able to validate their achievements.*
- Partially allowed the student to isolate the facts resulting in the greatest increase in efficiency in diagnosing that battery of cases. A goal of these analyses is to isolate specific critical facts for students to increase their lifelong knowledge bases. This was the most difficult part of this analysis to achieve, and only good to very good diagnosticians accomplished this. *Only after reaching a high plateau of diagnostic skill they were able to give self-credit for their achievements and understand how they got there. Future ability to trace paths to expertise will provide valuable comparisons to our work with group testing, and F Papa's work with case atypicality.*

Specific criteria were established to aid this detailed entry. Menus encouraged complete entry and the quantitative detail the students possessed at that time (94, 95). **As the KBIT software is used**, further quantitative detail was added. The KBIT software was a tool to help the student understand essential disease discriminators and definers, and to organize such understanding into his or her knowledge base. The KBIT program partially facilitated the

students' individual organization of discriminating and defining detail of each disease, increasing learning. **Near the end of the 3rd year professional Clinical Toxicology course,** the students were given one week to modify their protocol, and this protocol then was run against the same cases for a portion of their course evaluation. This trial was be open-book, time-limited and graded as a group of 3-4 students (34, 58, 94, 95). Structuring the disease model by understanding symptomatology incidence to differentiate among diseases and confirming the suspected disease was monitored using Knowledge Bit Information Transfer (KBIT; 94, 95, 95a).

Initial results with LGPBL: In a typical Toxicology class session at KSU, the students form into groups of six after a case presentation in order to elaborate the issues of problem identification, differential diagnosis, mechanisms, diagnostic confirmation, treatment, and client education, just as they will in their future practices. Only rarely are they limited by the issues the instructor had intended to cover. The students express different learning styles as evidenced by different levels of preparation, free talking, random writing and variable involvement with other students and with the faculty. Our students rarely agree, even within their groups. Thus, the clash of minds at least accompanies, and may be important to, student learning (24, 33, 47). Numerous studies of interactive learning strategies in a variety of settings ranging from elementary school to college report increases in student and teacher enjoyment of learning, in formal (reflective) thinking, and in learning content (73).

Students have sufficient enthusiasm so that most cover the assigned readings as indicated by their coming to class ready for the case and participating vigorously in the preliminary discussion of that case. There was an increase in the student-student and student-faculty class interactions, both of which contribute to the formation of mentorships and colleagueships that may be important as they enter practice. Students volunteered more comments during case analyses. Test scores were better than those from our lecture course of two year ago, even though the testing approach was changed from short answer to essay responses to case histories of practice situations. Many students had considerably more depth of understanding than we required for full credit on the oral examination. This fall, the percentage of such students increased with a second, and more than doubled with a third oral examination, indicating improved ability to relate to clients in a practice situation.

Some students reported that problem-based learning required more time to prepare. Students often did appear more anxious prior to their first examination and their oral evaluation, probably relating to a perceived inability to discriminate and organize essential clinical detail from each toxicant. While they did well on the tests, a survey showed that many did not take credit for their accomplishments, and instead attributed it to an external source such as the instructor. It is important to alleviate both of these factors by focusing student attention on their uniqueness and the extent of their learning through increasing student-student and faculty-student interactions (39).

Project results: In accomplishing these objectives, we validated 47 case-based videotapes, and canine and ruminant KBIT analyses of neurotoxicant space. We disseminated of our learning system throughout our college and into two other North American Veterinary Colleges. Academicians from Mexico, Brazil and other Pan American Veterinary Colleges have expressed interest in the possibility of translating our case-based scenarios which apply to their unique areas. Visually enhanced stories were filmed and produced as case-based videotapes. These tapes were used as the framework for advanced learning in junior clinical toxicology and mentoring clinical toxicologic medicine during their senior rotation. Groups improved student involvement and intragroup cooperation. Computer programs provided the means of deciding the essential features defining the clinical disease and differentiating this disease from other

similar diseases. This knowledge was evaluated using cases just like those encountered in veterinary practice. Students began to be able to tell just how good they really were--and take credit for their accomplishments--by evaluating their knowledge bases against a battery of clinical cases (KBIT; previously experienced as junior groups; 20-30% of the 1994 graduating class) and by answering randomly drawn "quiz-bowl" types of questions on their senior rotations, prior to taking their state board licensing examinations (10% + students from 1995 and 1996 graduating classes). This year, synopses of teaching cases placed on reserve after initial examinations (1995 Junior Class Clinical Toxicology), furthered this feature of learning.

Initial attempts to use group hourly evaluations met with frustration from students, because they could not arrive at a consensus for their examination questions, although students appeared at least as strong in clinical rotation as in previous years. This fall at Kansas State University, we made a second attempt and observed enhanced team performance on examination when compared to individual examination performance. We divided our class of 89 clinical toxicology students into learning groups of five to six individuals each. One third of the groups were quizzed as groups, while the remaining two-thirds of the students took the quizzes as individuals. The students responding in groups could recommend better treatments ($p \leq 0.05$), develop better diagnostic reasoning ($p \leq 0.05$), and explain better mechanisms ($p \leq 0.05$) of disease than could the remaining 2/3 of the students learning as groups but taking quizzes as individuals (93a). Although the group experience and its feedback improved students' ability to explain mechanisms of disease on a subsequent individual examination ($p \leq 0.05$), it did not lead to better overall examination performance, suggesting the strengths and limitations of future professional consultations. Students validated one anothers' recommendations for treatment, diagnostic hypotheses, and mechanistic explanations, representing beginning expertise-mastery (93a). By the second hour examination, groups had more treatment completeness and greater depth of explanations of mechanisms of clinical signs ($p < 0.05$ Student T) and increased test scores 1.5 weeks after the initial quiz. We hypothesize that additional steps toward expertise have been shown. The group experience enhances the adventure of difficult explanations, and that is most readily seen after some development, but proximate to the initial experience.

Transition to limited, temporary, expertise was noted on oral examination. Third-year veterinary medical students' oral examination commenced with students stating a species preference, drawing a case from a card-deck of one-paragraph cases and continued by them analyzing the case. Criterion for full credit was a working knowledge of those given for intergroup analysis in large-group problem-based learning. Students showing expertise equal to that expected in practice or beyond that of the instructor were noted (*). When selected students so graded were later interviewed, most were not aware of the quality of their performance. We have compared the transition rate of students taking no previous oral examination **(7%; 3 times)** to those undergoing a voluntary practice examination (in 1-week before examination 34 accessions from 18 students)**(10%)**, 1 previous examination **(11%)** and 2 previous oral examinations **(23%)**. Practice or the challenge of taking one or more previous examinations increased the rate of transition to temporary, limited, expertise.

Initial analyses of a KBIT small animal neurotoxicological problem-space will continue. Individual students (fourth-year) were compared to groups of 3-4 students (third-year) and to students working both as groups (third-year) and as individuals (fourth-year). Compared to beginning individuals, our groups modestly validated each others strengths (common toxicants +54%; PNS), but failed to compensate for each others weaknesses (less common toxicants -22%; $p \leq 0.1$ student T). Students with both team and individual experience compensated each

others weaknesses (+116% increase vs -22%; $p \leq 0.01$) effectively. KBIT allowed the students to clearly perceive their weaknesses.

Evaluation/Project Results

APPROACH: We proposed that evaluation procedures for this project be flexible and responsive to the project goals, activities, participants, and staff. Our change of chief evaluator from Dr Larry Enochs, John Staver (and W Pallett, V Clegg; 1st project year) to David Balk (and W Pallett, V Clegg; 2nd, 3rd and 4th project years) made this an especially pertinent proposal. The design took the form of the widely accepted Stake Responsive Model (Stake, 1975), that called for a multiplicity of data sources, including both qualitative and quantitative data. *Our data include qualitative and quantitative data, triangulation of qualitative with quantitative data, and triangulation of both qualitative and quantitative data with investigator observations. A strength of this model, is that we will continue to define relationships which will further the aims of this project, and to improve case-based learning.* This heuristic model led to better understanding of LG-PBL, SG-PBL and visual learning. Tentative working hypotheses, listed below, formed expectations subject to reformulation as the project proceeded. The discovery of new relationships, concepts, and understanding resulted. In addition, possible verification of the tentative working hypotheses emerged. The heuristic nature of the model led to such tangible payoffs as: 1) explanations of reasons for problems, the background of a situation, what happened, and why; 2) explanations of why the program worked or failed; and 3) an analysis of its applicability. In addition, this model was flexible enough to ascertain student gains on traditional measures and factor those results into resultant interpretations. Evaluations were depicted in the form of case study scenarios along with more traditional quantitative reports.

The process that was designed to evaluate the effectiveness of the enhanced LG-PBL program has two objectives: 1) to determine the impact of enhanced LG-PBL for students and for teachers (summative measures to assess improvement of student learning), and 2) to provide a basis for improving the program itself (formative measures to assess the program's success). To accomplish these objectives, several types of information, both quantitative and qualitative, were gathered and analyzed. Evaluation techniques include written and oral examinations, reports, and observations. In addition, regularly scheduled interviews of both students and faculty will be utilized.

Students from each of the 4 years of Veterinary program were sampled by pre-formed instruments, observation (78), videotapes (98, 99) or interview. In addition, we sampled Doctors of Veterinary Medicine in internships, residencies and as faculty (40).

A variety of evaluation techniques were used. Instructors established clear standards to guide in-class assessments (written examinations, oral evaluations) that determined how well students are accomplished the learning objectives in each course. These assessments were an inherent component in the instructional procedures of each course. Students, LG-PBL instructors, and professional staff on the clinical floor of the KSU Veterinary Teaching Hospital as well as at sites of clinical internships were surveyed regarding their evaluations of student progress toward the objectives listed above. Classes were videotaped and observed by a faculty development specialist so that student learning in the instructional situation could be carefully analyzed to determine the correlation to the established instructional objectives (8).

The assessments described above were be made during the project's four years (and will be made at a reduced level in subsequent years). During project months 8-18, long-term evaluation strategies were developed. These involved collecting several types of information from those who were in their clinical year. Among the information to be collected was: 1)

descriptions of confidence as pre-clinicians; 2) retrospective reactions to various facets of the enhanced LG-PBL program; and 3) supervisory ratings of how successfully 4th year students fulfilled various responsibilities.

In this project we tested several hypotheses relating to specific outcomes.

1) Practitioner/Faculty-generated cases increased student involvement. Visual enhancement will increase it still further. Involvement was measured as student-student and student-faculty interaction by randomly sampling videotapes taken throughout the course to document the enrichment of LG-PBL. Validity of sampling such tapes was suggested by Patton (98). In addition, interviews of purposively sampled and volunteer students was conducted. The same students were used throughout the course to ascertain trends and emerging data. These interviews will be transcribed and analyzed by way of content analysis. The evaluators interpreted these resultant analyses and generated assertions. The interviewees assisted in the analysis to corroborate the findings.

2) The enhanced cases altered student behavior from listening and repeating and relating to analyzing and creating and evaluating. Change in behavior was detected by direct expert observation of videotapes sampled at random from classes using enhanced LG-PBL (98). The evaluation process determined the degree to which students develop higher order cognitive processes essential to diagnostic and decision-making abilities, e.g., applying ideas in new situations, analyzing to discover hidden meaning and to distinguish between fact and opinion, and formulating distinct criteria on which to base judgments.

3) The enriched cases led to qualitatively greater depth of performance. Cooperative learning will enhance it still further. This was demonstrated as the relative incidence of practitioner quality answers during oral evaluations. One of the coinvestigators (JAP) has been recording the occurrence of such answers as part of the oral examinations in Clinical Toxicology. This is a qualitative, observational measure of temporary transition from "pre-expert" to "expert." In an LG-PBL class not previously given such examinations, the incidence is 7%. This incidence increases to 11% when the class have all had one previous oral examination, and to 23% when they have had two examinations. Interviews shed light on this hypothesis. Readiness for professional practice was assessed not only as a function of basic knowledge and understanding and decision-making ability but also as a function of important professional skills such as effective communication, the ability to interact with clients and professional colleagues in new settings, and the ability to continue learning independently.

4) Modified K-BIT accurately discriminated between low and high levels of diagnostic skill by using an expert panel of practitioners. Expert practitioners (practicing clinicians) formed the benchmark of performance against which knowledge bases are judged. Moreover, the percentage of the case battery which such experts correctly diagnose was higher than with the same novices. A reflection of their diagnostic maturity was dependent on precise definers of the model, as opposed to discriminators from similar diseases anticipated for novices.

5) Linking the greater proportion of essential visual and written detail from enhanced case formation to computer software, enriching significant content of student knowledge bases led to enhanced performance. KBIT profile were cross linked to round performance in senior rotation, but no clear trends have as yet emerged.

6) Differences in pathway reflected differences in diagnostic maturity (relative degree of clinical experience) and different clinical decision making style. KBIT software did not allow testing of this hypothesis at this time.

7) Because of this trial, at least 80% of the groups of six students took credit for pre-expert to expert transition. Pre-expert to expert transition was demonstrated as

unusual depth of performance (see test of hypothesis #3) and an increase in diagnostic maturity. That students took credit for the transition was validated by student survey of Junior Clinical Toxicology. Additional validity was gained by way of interviews (see hypothesis #1). PBL did bolster self confidence.

RESULTS: During the first project year, we focused on standardizing our evaluation technique and team. We detected novice to limited expert transitions and expanded that measurement. During the second project year, D Balk agreed to head the evaluation team, and we initiated qualitative and quantitative surveys about the nature of PBL. From this several widely held beliefs (themes) and hotly contested issues were confirmed. We evaluated use of LG-PBL in the first portion of the toxicology course, and placed it in the context of what it was like to be a 3rd year veterinary student. We evaluated the confirmation or lack of confirmation of our hypotheses for this project. Teaching partners (CE Layton, JA Pickrell) is included because it provides additional means of triangulation of data collected from the formal evaluations, and to provide experience for investigators in ongoing in classroom evaluations.

Teaching partners, a partnership between 2 teachers of roughly equal expertise in which we visit each others classes 3 times and interview 3 students) excited veterinary students because faculty effort was directed toward improving their education and their opinion had been asked. **Students revealed a bias toward action (hands-on experience)**, regarding it as their best learning experience. Our evaluators correctly raise the issue that too much of this good thing could lead to students becoming technicians of Veterinary Medicine, rather than true practitioners. The teaching partners take our responsibility to guide them so that this does not happen seriously. **Students increasingly used groups for consultation** throughout their education, learning in groups, and as their predominant method of study. Our previous evaluator surveys reveal that some form of lecture and problem-based learning is overwhelmingly preferred as security to validate their learning. As partners, we point out that this shortens intragroup/team learning. An alternative to this apparent paradox is to test in a group. If this is always done, the novelty quickly wears off, and teams have trouble agreeing. This fall preliminary data (see above) was gathered where we alternated between testing in groups and individually, teams lead individuals to significantly increased competence in treatment, diagnostic reasoning and explanation of clinical signs, leading occasionally to increased competence on individual examinations. **Students** especially **appreciated the support** provided by these teaching partners, although many felt it to be instructor dependent with respect to their other instructors. **Students** really liked **individual oral examinations**, especially those in which questions of ordered difficulty were given, supporting the examination's positive outcome. Our preliminary data suggests minimum time/student should be 10 minutes. Our evaluators correctly point out that examining groups of 4 students in 15 minutes suggested the need for more time, although students were clearly involved. Most (71%) of the students felt that examinations in the partners courses accurately measured their knowledge.
Summary form was judged to provide better understanding than graphs.

Themes (widespread beliefs) uncovered by interviews were (those confirmed are italicized and underlined. Investigator comments are italicized):

- Students are responsible for their learning (*but they resist this*).
- PBL works when objectives are clear.
- Evaluating effects of PBL is a shared faculty concern.
- The College of Veterinary Medicine instills and promotes student fear of faculty (*or a fear of not measuring up). Professional year students in years 1-3 express a need for perfection. Maturity allows increased perception of reality.*
- Relevance of information should drive curriculum decisions

- Students learn more once they enter veterinary practice. *Students take credit for achievements with difficulty until after they graduate. This belief may be an illusion of structuring in practice as they encounter problems. The survey was conducted too early to see any effects of PBL.*
- Groups provide a break from lectures (our surveys show this too).
- PBL takes a lot of time (*although it doesn't have to be that way; confirmed*).
- Ambiguity is inherent in PBL (*confirmed*).
- Facilitators are the key to student success in small-group problem-based learning (PBL)(*confirmed*).

Issues dividing stakeholders over PBL (those confirmed are italicized and underlined):

- The administration of the College of Veterinary Medicine is committed to PBL.
- Prior knowledge is needed for students to profit from PBL.
- Some courses are not appropriate for PBL
- The meaning of PBL is a concept shared by all in the College of Veterinary Medicine.
- Combining lectures and PBL would be more effective than running lectures or groups by themselves (*confirmed*).
- PBL builds student confidence (*confirmed*).
- PBL increases retention of information (*confirmed*).
- PBL promotes in-depth learning at the expense of breadth of coverage (*confirmed*).

In addition, Dr. Balks team confirmed that Learning the process of problem solving is a goal of PBL.

Evaluation of the Toxicology Course, indicated partial validation for the following objectives (investigator comments are italicized):

- Faculty provided a structure which will allow students to integrate what they have learned and enhance student transition to temporary experts. *We present quantitative evidence of such transition on oral examinations. However our evaluators correctly point out that students present powerful resistance for being responsible for their own learning.*
- Faculty provided exams which foster a colleague to colleague, not instructor to pupil relationship in order to facilitate learning. *We did foster an instructor-dependent colleague to colleague relationship.*
- Faculty developed tests which reflect the ability of the students. *71% of students from the teaching partner survey conducted after students had received their grades felt that exams fairly reflected their ability. However, students arguments indicated expectations of coverage only of material in class, but were held to material assigned. Arguing with referees at sports contests come to mind.*
- Students changed learning strategies from memorization to learning throughout their professional careers. *Students understood basic mechanisms, preferred to have them explained by the instructor and preferred to look up details, much like group consultation in practice.*
- Education was direct instead of student self-study after lecture, empowering and challenging the student through the use of real-life problems. *In one course of 7, students prepared and discussed cases well until mid-semester when the increased time commitments became overwhelming, and the instructor assumed more responsibility for their learning.*

Case studies of 3rd year veterinary students revealed the following (investigator comments are italicized):

- Students receive large amounts of information causing them to fall behind throughout the year. From mid-semester students do only enough to receive their target grade (typically an A or B). *It is much harder to implement PBL in the last half of the semester, and almost impossible to do it in isolation (1 course in 7).*
- Student's lives reflect their scheduled hourly tests (0, 1 or 2) for the week (*at odds with next*).
- Students use their spare time to do things that they enjoy, that is they don't study all the time (*at odds with previous*)(*yet this report provides examples of giving up cherished activities; these decisions reflects decisions needed in most practice lives; and students really love veterinary medicine*).
- An A or a B is an acceptable grade for a 3rd year veterinary student (*this is at least regionwide, but limited preliminary data suggests that these goals are not achieved*).
- Groups serve an important function in the lives of veterinary students. They rely on and support each other—in laboratories and in other ways. *Our preliminary data says that group and individual testing can help students learn more effectively.*
- The 3rd professional year clearly marks the transition between the first 2 years of basic science and the clinical year (4th year) before students enter their practice life. *Students hold to what has allowed them to survive and prosper, and resist activities pushing them toward their senior year, while indicating a desire to get into the clinics. As faculty, we must help them make this transition (**see next point**).*
- The main concern of 3rd year professional students is preparation for the 4th year. 3rd year students fear (or question their learning or measuring up to) the mysterious 4th year rotations (***see previous point***). *As faculty, we tell them to investigate further, nearly all of their predecessors have survived and are prospering in practice, so can they. This generally dispels their anxiety.*
- Students do not believe the national board is an effective method of testing their skills as practicing veterinarians, they favored their ability to apply skills learned (*not too different from the apprenticeship model of days gone by*). *Students do need to be licensed to practice, we must help them achieve their dreams.*
- Students showed signs of burnout during their 3rd professional year (*possibly the burnout [unfinished business] is a function of the large amounts of information and the impossibly high self imposed standards they experience*).
- Students respect faculty who treat them with courtesy (willing to help outside of class; grade exams promptly; treat them like professional colleagues) and who have significant practical experience (knowledgeable; provide practical information in a way that they can understand). *Our practitioner-generated, case-based videotapes were well received because of this.*

Our evaluators and investigators validated the following hypotheses during this project. **CASE BASED VIDEOTAPES: Practitioner-generated cases and case-based videotapes did increase student involvement** (*Hypotheses #1 and 2*) as estimated by instructor (55-85%), observer (>75%) and by videotapes of selected lectures (>90%). Our evaluators point out that in small groups, involvement is facilitator dependent, a fact borne out by literature on PBL. **Case-based learning did increase the incidence of practitioner quality answers** on oral examinations (*Hypothesis #3*), and groups supported students and promoted interaction. However, a minimum of 10 minutes was required for each student, whether in a group or not.

Our evaluators note correctly that 15 minutes/group of 4 is insufficient to have students perceive themselves as being evaluated completely. **At least 80% of the students did not take credit for transition from novice to limited pre-expert** (*Hypothesis #7*). Either our estimate was optimistic, or our methods insensitive. We find that validation of learning is difficult to get students to admit and estimate the **rate** at **10-60%**, increasing with supportiveness of instructor, practicality of conditions and maturity of student.

KNOWLEDGE BIT INFORMATION TRANSFER PROFILES: KBIT computer profiles of the neurotoxicant problem space in small animals could distinguish mastery levels of diagnostic skills from low levels of diagnostic skills (*Hypotheses #4 and #5*) as indicated by comparing senior skills near performance expected for practice with enhanced skills of students first analyzing the profile as a team of 3-4 juniors and subsequently as individual seniors (data reported under KBIT neurotoxicological profile analysis). Our experience suggests that because of its complexity of diagnostic reasoning by computer, the profile underestimates diagnostic skill of students with low to moderate diagnostic skill. As students approach mastery, progress appears to be quite rapid (94, 95). Students more easily identify areas which need work, and had more difficulty taking credit for their achievements. The *6th hypothesis*, **that students with high diagnostic efficacy would have a different diagnostic path** was not testable with current KBIT computer software which could not track more than an initial and a final answer. Our preliminary data suggesting that group examinations drive treatment and explanatory inventiveness suggest the scientific validity of this hypothesis.

Dissemination: KSU Institutionalization—Residents and faculty participated in the making and using of these videotapes. Several sections use related tapes, their tapes as part of their senior rotation. **Nation/international dissemination**—12 videotapes are in 2 colleges of veterinary medicine, University of Texas (College Station, TX) and Atlantic Veterinary College (Prince Edward Island, Canada). Numerous presentations have been made throughout the veterinary and toxicology professions demonstrating tapes, their utility and future directions of this research. Practitioners at our annual conference, students who are graduating and veterinarians from Mexico, Brazil and other panAmerican countries (translation required) have expressed interest in our case-based videotapes to model clinical conditions. Dissemination of videotapes continues.

Residual benefits from the project: Students learned the richness and variety of practice cases associated with toxicology, many aspects of veterinary medicine. The students interfaced with practitioners who will have a chance to see just how expert they are becoming in their differential diagnoses and problem solving as indicated by our increasingly active externship program. **Faculty** achieved satisfaction in enhanced student learning and practice expertise deriving from LG-PBL. However, they experienced misgivings about the perceived lack of breadth of coverage as they compared their students achievements with those of more conventionally taught courses. Such anxieties are common in the medical profession for both students and faculty. The heavy evaluation emphasis aided faculty in forming their teaching portfolios, increasing their value throughout professional education. Researchers with little teaching experience were brought up to speed to use PBL in academia. This flexibility in recruitment will make it more likely that recruited faculty will form centers of excellence for research and to lead post graduate or post doctoral students. The first such center at KSU College of Veterinary Medicine currently focuses on beef production medicine and animal science. Future plans and funding include leading of graduate or post doctoral students. **Practitioners** and their clients are the ultimate beneficiaries of improved training, clinical acuity and practice efficiency in our graduates. Tomorrow's practitioners will be challenged by the

increasingly complex problems of veterinary medicine, most of which they had no role in creating. Closer liaison with veterinary educators and specialists allows improvement of continuing education and provides data upon which improved clinical decision-making skills can grow as well as making more efficient use of tertiary health care in veterinary medical centers. **Our vision of the future** includes further definition of the path to expertise. Currently, one investigator (JAP) tests in groups and individually and have demonstrated increased effectiveness of treatment, diagnostic reasoning and ability to explain mechanisms behind development of clinical signs on group efforts. Students also show increased ability to explain mechanisms on individual tests, and greater willingness to invent better treatments and explanations as indicated by their participation in these difficult questions on an hourly examination. We believe these activities represent initial steps on the path to expertise. We believe that they are reinforced by review of our case-based videotapes. Finally, we believe that they can be detected using the KBIT profile of F Papa (TX Coll Osteopath Med, Ft Worth, TX) and his simultaneous measurement of knowledge base with varying case atypicality.

Summary and Conclusions: Forty-seven case-based videotapes were produced and are used to model clinical conditions at KSU College of Veterinary Medicine, increasing student involvement and the quality of their learning. Learning appears greater if oral examination questions are ordered from simple to complex. The neurological problem-space of 3rd year veterinary students was evaluated most successfully in initial groups and subsequently as individuals, distinguishing skilled from novice diagnostic reasoning. Our evaluation team and investigator triangulated findings reveal that PBL fosters significant advantages, increased student confidence and in-depth learning. However, PBL's significant disadvantages, reduced breadth of learning, considerable time requirements, and significant ambiguity while learning are regarded as barriers to introducing PBL curriculum wide in many higher educational institutions.

REFERENCES CITED

1. Abrahamowicz, M., R.M. Tamblyn, J.O. Ramsay, D.K. Klass and M.L. Kopelow, Detecting and correcting for rater-induced differences in standardized patient tests of clinical competence. Acad. Med. 65:S25-S26.
2. Anderson, J.: 1982. Acquisition of cognitive skills. Psychol Rev. 89:369-4062.
3. Andruzyszyn, M.A.: The effect of the lecture discussion teaching method with and without audio-visual augmentation on immediate and retention learning. Nurs. Educat. Today 10:172-180.
4. Alkin, M.C.: 1990. Debates in evaluation.
5. Alkin, M.C.: 1979. Using evaluation: Does evaluation make a difference?
6. Aspin, Alexander.: Achieving educational excellence, a critical assessment of priorities and practice in higher education. Jossey-Bass, San Francisco, CA. 254 p.
7. Arias, I. M.: 1989. Sounding board: Training basic scientists to bridge the gap between basic science and its application to human disease. New England J Med. 321:972- 974.
8. Ballard, A.L.: 1990. Getting started. Writing behavioral objectives. J. Nurs. Staff Dev. 6:40-44.
9. Baron, J., and R. Sternberg.: 1987. Teaching thinking skills. WH Freeman Co., New York, NY. 275.
10. Barrows, H. S.: 1986. A taxonomy of problem-based learning methods. Med Educat. 20:481-486.

11. Barrows, H. S., and P. J. Feltovich.: 1987. The clinical reasoning process. Med Educat. 21:89-91.
12. Barrows, H., A. Myers, R. Williams, and E. Moticka.: 1986. Large group problem-based learning: a possible solution for the 2 sigma problem. Med Teacher. 8:325-331.
13. Belbeck, L.: 1989. Unpublished research communication. McMaster Univ, Montreal, CAN.
14. Bennett, W.J.: 1988 (Nov.). Lessons from great schools. Readers Digest pp 121-125.
15. Berner, E. S.: 1984. Paradigms and problem solving a literature review. J Med Educat. 59:625-1193.
16. Betts, A.O.: 1991 (Jan 5). Evaluation of veterinary education in Europe. Vet. Rec. pp. 6-7.
17. Beyerman, K.: 1990. Committee work: serendipitous teaching and learning. J. Contin. Educat. Nurs. 21:18-22.
18. Bishop, C. W.: 1989. A name is not enough. MD Comput. 6:200-206.
19. Blane, C. E., K. H. Vydarneny, J. D. Ten-Haken, and J. G. Calhoun.: 1989. Problem solving model in radiology for medical students. Australas Radiol. 33: 173-174.
20. Black, J.E., K.R. Isaacs, B.J. Anderson, A.A. Alcantara and W.T. Greenough.: 1990. Learning causes synaptogenesis, whereas motor activity causes angiogenesis, in cerebellar cortex of adult rats. Proc. Natl. Acad. Sci. 87:55128-5572.
21. Boecker, E. A.: 1990. Special Feature: Criteria for successful careers. FASEB J. 4:252-254.
22. Bordage, G. and M. Lemieux.: 1990. Structure Medical Cognition. Which Medical Textbook to read? Emphasizing semantic structures. Acad. Med. 65:s23-s24.
23. Bower, G. H., and D. G. Morrow.: 1989. Mental models in narrative comprehension. Science. 286:44-86.
24. Breo, D.: 1990. A gifted teacher and storyteller writes about his medical adventures. JAMA. 2119(5):725-727.
25. Brudenell, I., and C.S. Carpenter.: 1990. Adult learning styles and attitudes toward computer assisted instruction. J. Nurs. Educat. 29: 79-83.
26. Buddle, J.: 1989. A problem solving format for written examinations in veterinary clinical subjects. Veterinary Record. 125:258-2115.
27. Burrows, S., D. S. Ginn, N. Love, and T. L. Williams.: 1989. A strategy for curriculum integration of information skills instruction. Bull Med Lib Assoc. 77:245-251.
28. Campbell, J. R.: 1972. In touch with students...A philosophy for teachers. Educational Affairs Publ., Columbia, MO.
29. Cash, W.: 1990. Student remembering, making connections to knowledge. FROM Unpublished communications. Kansas State University, Manhattan, KS 66506-5606.
30. Castro, C.A., R. Paylor, T.B. Moye and J.W. Rudy.: 1990. The cholinergic agent physostigmine enhances short-term-memory-based performance in the developing rat. Behav. Neurosci. 104:390-393.
31. Casteel, C. P., N. A. Mortillaro, and A. E. Taylor.: 1989. Teaching-effectiveness analysis plan applied to lectures in medical physiology. Am J Physiol (Adv Physiol Educat 1). 256:S3-S8.

32. Cavazos, L.F.: 1990. Restructuring education and its impact on medical education. Acad. Med. 65:230-233.
33. Christensen, R., and A. Hansen.: 1987. Teaching and the Case method. Harvard Business School, Boston, MA.
34. Clegg, V.: 1990. Unpublished research communication. Kansas State University, Manhattan KS.; Gerald Hanna, 2/1/1990. Evaluating Student Performance, First Friday Lunches, KSU, Manhattan, KS 66506-5606
35. Cohen, J.: 1988. Statistical power analysis for the behavioral sciences (2nd ed). Erlbaum Associates, Hillsdale, NJ.
36. Coughlin, L. D., and V. L. Patel.: 1987. Processing of critical information by physicians and medical students. J Med Educat. 62:818-828.
37. Cross, K. Patricia.: 1991. Improving College Teaching. Kansas City Regional Council For Higher Education Conference. Avila College, 2/8/91. Kansas City, MO.
38. Cross, K. Patricia.: 1985. *Education for the 21st Century*. NASPA Journal. April:7-18.
39. Dietrich, A.J., M. Moore-West, D.R. Palmateer, J. Radebaugh, S. Reed, B. Clauson.: 1990. Adapting problem-based learning to a traditional curriculum: teaching about prevention. Fam. Pract. Jour. 10:65-73.
40. Dillman, D.A.: 1978. Mail and telephone surveys: the total design method. Wiley. New York, NY.
41. De-Graff, E.: 1989. A test of medical problem-solving scored by nurses and doctors: the handicap of expertise. Medical Education. 23:381-386.
42. Duckwall, J.M., L. Arnold, T.L. Willoughby, E.V. Calkins and S.C. Hamburger.: An assesment of the student partnership program at the University of Missouri-Kansas City School of Medicine. Acad. Med. 65:697-701.
43. Donner, R.S. and M. Bickley.: 1990. Problem-based learning, an assessment of its feasibility and cost. Human Pathol. 21:881-885.
44. Eble, K. E.: 1976. The craft of teaching. Jossey-Bass Publ., San Francisco, CA. /@8
45. Elkind, D.: 1989. Letter to the editor; Educational reform. Science. 244:1191-1192.
46. Ettinger, S.: 1989. Textbook for veterinary internal medicine. WB Saunders Co., Phil., PA.
47. Fenwick, B.: 1990. Unpublished research communication. Kansas State University, Manhattan, KS.
48. Ferguson, M.: 1980. The Aquarian Conspiracy: Personal and social transformations in the 1980's. J.P. Tarcher, Los Angeles, CA, 448 p.
49. Fisher, R. and W. Ury, 1981. Getting to YES. Houghton, Mifflin, R.R. Donnelley and Sons, Harrisonburg, VA 161 p.
50. Friedman, M., M. Prywes, and J. Benbassat.: 1989. Variability in doctors" problem-solving as measured by open-ended written patient simulations. Medical Education. 23:270- 275.
51. Furman, B., and T. Ahola.: 1988. Return to the question "why": advantages of exploring pre- existing explanations. Fam Process. 27:395-409.
52. Galatzer-Levy, R. M.: 1988. On working through: a model from artificial intelligence. J Am Psychoanal Assoc. 36:125-151.

53. Gardner, M.A.R.: 1989. Doubly modifiable synapses: a model of short and long term auto-associative memory. Proc. Roy. Soc. London [Biol.] 238[1291]:137-154.
54. Garner, Ruth.: 1990. When children and adults do not use learning strategies: Toward a theory of settings. Rev. Educat. Res. 60:527-529.
55. Gessner, B. A.: 1989. Adult education. The cornerstone of patient teaching. Nurs Clin North Am. 24:589-595.
56. Glaser, R.: 1984. Education and Thinking; the role of knowledge. Am Psychologist. 39(2):93-104.
57. Goodyear, R., and M. A. Hautman.: 1989. Conflict resolution: applying the political model to the RCT proposal. Nurse Pract. 50:53-54.
58. Gott, S.: 1988. Technical intuition in system diagnosis, or accessing the libraries of the mind. Aviat., Space, Environ. Med. 59 (11 pt.2): A59-64.
59. Grant, W.: 1988. The Education of professionals. Intervet. 24:3.
60. Greenfield, L. B.: 1987. Teaching thinking through problem solving. In: "Developing critical thinking and problem-solving abilities", Stice, JE, ed., Jossey-Bass, San Francisco, CA. pp. 5-21.
61. Hains, A. A., and A. H. Hains.: 1987. The effects of a cognitive strategy intervention on the problem- solving abilities of delinquent youths. J Adolesc. 10:399-413.
62. Hannah-White, C.M., J.M. Lewkowicz, R.V.H. Pollock, CORKS: a MUMPS-based implementation of a knowledge network. Presentation for MUMPS group users meeting, June, 1988.
62a. Herbert F, 1981. Death of a city AND Try to remember in *Eye*, F Herbert ed., pp 117-158; 313-324, 328 p.
63. Hidi, Suzanne.: 1990. Interest and its contribution as a mental resource for learning. Rev. Educat. Res. 60:549-571.
64. Hirt, E. R., and N. J. Castellan.: 1988. Probability and category redefinition in the fault tree paradigm. J Exper Psychol. 14:122-131.
65. House, E.R.: 1980. Evaluating with validity. Sage, Beverly Hills.
66. Jelovsek, F.R., V.A. Catanzarite, R.D. Price and R.E. Stull.: 1990. Learning theory and knowledge structures in computer-aided instruction. MD Comput. 7:98-103.
67. Jick, T.D.: 1983. Mixing qualitative and quantitative methods: triangulation in action. Sage Publ., Beverly Hills, CA, pp. 135-148.
68. Johnson, D., R. Johnson, E. Holubec, and P. Roy.: 1988. Circles of learning. Edwards Bros. Inc., Minneapolis, MN.
69. Joseph, G.M. and V.L. Patel.: 1990. Domain knowledge and hypothesis generation in diagnostic reasoning. Med. Decis. Making 10:31-46.
70. Kanki, B. G., S. Lozito, and H. C. Foushee.: 1989. Communication indices of crew coordination. Aviat Space Environ Med. 60:59-60.
71. Kirchner, L.: 1990. Unpublished research communication. Johnson County Community College.
72. LaVerne, R.: 1989. The President's Notebook: The promised land. Intervet. 25:6.
73. Lawson, A.E., M.R. Abraham and J.W. Renner.: 1989. A theory of instruction: Using the learning cycle to teach science concepts and thinking skills. National Association for Research in Science Teaching (NARST) Monograph, Number One, p 131.

74. Leith, D., and N. Anderson.: 1988. Discussion of unpublished results. FROM Proposal to the PEW National Veterinary Education Program. Kansas State University, Manhattan, KS 66506-5606.

74a. Lewin R, 1992. Complexity: Life at the edge of chaos. MacMillan, NY 209 pp.

75. Livo, N.J. and S.A. Reitz.: 1986. Storytelling, Process and Practice. Libraries Unlimited Inc., Littleton, CO, 462 p.

76. Light, R.J., J.D. Singer and J.B. Willett.: 1990. By Design: Planning research on higher education. Harvard University Press, Cambridge, MA. 272 p.

77. Light, R.J.: 1990. The Harvard Assessment Seminars: Explorations with students and faculty about teaching, learning, and student life (First Report), Work supported by Foundation for Improve. Post Secondary Education and Andrew Mellon Foundation, 95 p.

78. Light, Donald Jr.: 1983. Surface data and deep structure: observing the organization of professional training. Qualitative Methodology. J. VanMaanen ed., Sage Publ., Beverly Hills, CA, pp. 57-69.

79. Libet, B.: 1990. Subjective Perception. Science. 286: 727.

80. Lobeck, C.C. and H.L. Stone.: 1990. Class mentors: a step toward implementing the GPEP report. Acad. Med. 65:351-354.

81. Logothetis, N. K.: 1990. Subjective Perception. Science. 286: 727.

82. Love, R.R.: 1990. Methods for increasing active medical student participation in their own learning: experience with a single 30 hour course for 111 preclinical students. J. Cancer Educat. 5:33-36.

83. Malamud, B.: 1989(May). Quoted by Israel Schenker, NY Times, Points to Ponder. Readers Digest pp 48.

84. Massironi, M.: 1988. A new visual problem: phenominic folding. Perception. 17:1281- 694.

85. Miller, R.A. and N.B. Guise.: 1991. Medical Informatics: Medical Knowledge Bases. Acad. Med. 66:15-17.

85a. McKeachie WJ, Pintrich PR, Lin Y-G, Smith DAF, Sharma R, 1986. Teaching and learning in the college classmoom—A review of the research literature (2nd edition), Program on teaching and learning strategies, research to improve teaching and learning, Univ MI, Ann Arbor, MI 48109-1259, 129 pp.

86. Mikulincer, M., and B. Nizarin.: 1988. Causal attribution, cognitive interference, and the generalization of learned helplessness. J Pers Soc Psychol. 55:860-868.

87. Mishkin, M. and T. Appenzeller.: 1987. The anatomy of memory. A Scientific American special report. pp 1-11.

88. Monnat, R.: 1989. How do we teach pathology? General pathology teaching at the university of washington. J Pathol. 159:345-349.

89. Nelson, T.J. and D.L. Alkon.: 1990. Specific high molecular weight m-RNAs induced by associative learning in *Hermissenda*. Proc. Natl. Acad. Sci. USA 87:269-273.

90. Nelson-Le Gall, S. and E. Jones.: 1990. Cognitive-motivational influences on the tase-related help-seeking behavior of black children. Child Dev. 61:581-589.

91. Newble, D., and R. Cannon.: 1987. A handbook for medical teachers, 2nd edition. MTP Press LTD, Boston, MA. ,0@8

92. Norman, G. R.: 1988. Problem-solving skills, solving problems and problem-based learning. Med Educat. 22:279-286.
93. Novick, L. R.: 1988. Analogical transfer, problem similarity, and expertise. J Exp Psychol. 14:510-520.
93a. Oehme FW, Pickrell JA, Loughin T, 1996. Group learning models consultation and beginning expertise in a professional practice. Toxicology (in press).
94. Papa, F., and S. Meyer.: 1989. A computer-assisted learning tool designed to improve clinical problem-solving skills. Ann Emer Med. 18:269-273.
95. Papa, F.J., J.H. Shores and S. Meyer.: 1990. Structure of medical cognition: Effects of pattern matching, pattern discrimination and experience in the development of diagnostic expertise. Academic Medicine 65:S21-S22.
95a. Papa FJ, Schumacker R, Aldrich D, Stone R, 1995. Assessing disease class-specific diagnostic ability: a practical adaptive test approach. Paper presented at the October Mid-West Educat Res Assoc.
96. Patel, V.L., G.J. Groen and J.F. Arocha.: 1990. Medical expertise is a function of task difficulty. Med. Cognit. 18:394-406.
97. Patel, V.L., D.A. Evans and D.R. Kaufman.: 1990. Reasoning strategies and the use of biomedical knowledge by medical students. Med. Educat. 24:129-136.
98. Patton, M.Q.: 1990. Qualitative evaluation and research methods (2nd ed.). Sage, Beverly Hills, CA. 532 p.
99. Patton, M.Q.: 1986. Utilization focused evaluation (2nd ed.). Sage, Beverly Hills, CA.
100. Peters, T.: 1988. Thriving on Chaos, Handbook for a management revolution. Perennial Library Edition Harper and Row, New York, NY. 180-181.
101. Pickrell, J., and F. Oehme.: 1989. Unpublished research communication. Kansas State University, Manhattan, KS.
102. Pickrell, J.A.: 1990. Teaching strategies: a comparison of master teachers to fully adequate teachers. Paper for EDCI 843, May, Kansas State University, Manhattan, KS.
103. Pollock, R.: 1989. Computer-aided Diagnosis. In: "Current Veterinary Therapy. Small Animal Practice", Kirk, RW, ed., WB Saunders Co., Phil., PA. pp. 2-7.
104. Pollock, R.V.H. and T. Fredericks.: 1988. PROVIDES: a complete veterinary medical information system. Can. Vet. Jour. 29:265-270.
105. Pool, R.: 1991. Scientific literacy: the enemy is us. Science 251:266-267.
106. Putnam, J. W., J. E. Rynders, R. T. Johnson, and D. W. Johnson.: 1989. Collaborative skill instruction for promoting positive interactions between mentally handicapped and nonhandicapped children. Except Child. 55:550-557.
106a. Redfield J, Adrienne C, 1995. The celestine prophecy: An experiential guide. Time Warner, New York, NY 285 p.
107. Regan-Smith, M.G. and D.A. West.: 1990. Teaching critical thinking in the context of substance abuse in a psychiatry clerkship. Academic Medicine 65:89.
108. Reed, S.K., C.C. Ackinclose and A.A. Voss.: 1990. Selecting analogous problems: similarity versus inclusiveness. Mem. Cognit. 18:83-98.
109. Riegler, H. C., and D. M. Baer.: 1989. A developmental analysis of rule-following. Adv Child Dev Behav. 21:P 191-219.
110. Rosenthal, R.: 1989. Working together to learn. JAVMA. 195(11):1868-1480.

111. Rossi, P.H. and H.E. Freeman.: 1982. Evaluation: A systematic approach. 3rd ed.
112. Rubenstein, M. F., and I. R. Firstenberg.: 1987. Tools for thinking. In: "Developing Critical Thinking and Problem Solving Abilities", Stice, JE, ed., New Directions for Teaching and Learning Jossey-Bass, San Francisco. pp. 23-35.
113. Russell, I. J., W. D. Hendricson, and R. J. Herbert.: 1984. Effects of lecture information density on medical student achievement. J Med Educat. 59:881-889.
114. Rutman, L.: 1984. Evaluation research methods: a basic guide. (2nd ed.), Sage, Beverly Hills, CA.
115. Schmidt, H. G., W. D. Dauphinee, and V. L. Patel.: 1987. Comparing the effects of problem-based and conventional curricula an international sample. J Med Educat. 62:305- 315.
116. Schmidt, H.G., G.R. Norman, and H.P.A. Boshuizen, A cognitive perspective on medical expertise: theory and implications.
117. Schuell, T.J.: 1990. Phases of meaningful learning. Rev. Educat. Res. 60: 531-586.
118. Schwartz, W.: 1989. Documentation of students' clinical reasoning using a computer simulation. Am J Dis Child. 143:575-579.
119. Seto, W. H., P. T. Ching, J. P. Fung, and R. Fielding.: 1989. The role of communication in the alteration of patient care practices in hospital-a prospective study. J. Hosp. Inf. 14:29-37.
120. Shadish, W.R., T.D. Cook and Laura C. Leviton.: 1990. Foundations of program evaluation. Sage Publ., Newbury Pk., CA, 529 p.
121. Shahabudin, S. H.: 1987. Content coverage in problem-based learning. Med Educat. 21:310-313.
122. Sherman, T.M., L.P. Armistead, F. Fowler, M.A. Barksdale and G. Reif.: 1987. The quest for excellence in university teaching. Jour. Higher Educat. 48:66-84.
123. Sheehy, Gail, 1981. Pathfinders. Bantam Books, New York, NY, 625 p.
124. Sinnott, J.: 1989. Everyday problem solving, theory and applications. Praeger Publications, New York, NY.
125. Small, P. A.: 1988. Consequences for medical education of problem-solving in science and medicine. J Med Educat. 119:848-853.
126. Soumerai, S. B., and J. Avorn.: 1990. Principles of educational outreach (Academic Detailing) to improve clinical decision-making. JAMA. 2119(4):549-556.
126a. Sternberg RJ and Frensch PA, 1991. Complex problem solving: Principles and mechanisms. Doubleday, New York, NY 593 pp.
127. Sutherland, R.J. and R.J. McDonald.: 1990. Hippocampus, amygdala and memory deficits in rats. Behav. Brain Res. 37:57-79.
128. Sternberg, R. J., and J. Gastel.: 1989. If dancers ate their shoes: inductive reasoning with factual and counterfactual premises. Mem Cognit. 17:1-10.
129. Thorne, S. E., and C. A. Robinson.: 1988. Reciprocal trust in health care relationships. J Adv Nurs. 13:782-789.
130. Toffler, W.I., A.E. Sinclair, M.S. Darr, D.L. McGinty, K. Commerford, and R. Goetz.: 1990. Using a sociomatrix to evaluate the effectiveness of small-group teaching to residents. Academic Medicine 65: 654-655.
131. Tsai, L. S.: 1987. Overt vs covert problem solving, transfer effects and programming sequences: I: inverted triangles. Percept Mot Skills. 65:313-314.

132. Twain, M.: 1988 (Nov). Quotable quotes. Readers Digest, pp 33.
133. Van Wallendael, L.R. and R. Hastie.: 1990. Tracing the footsteps of Sherlock Holmes: cognitive representations of hypothesis testing. Mem. Cognit. 18:240-250.
133a. Waldrop MM, 1992. Complexity: The emerging science at the edge of order and chaos. Simon and Schuster, New York, NY, 318 pp.
134. Watkins, B. T.: 1989. Personal and Professional: For many teachers, classroom lecture is giving way to projects that students tackle in small groups. The Chronicle of Higher Education. August 2:A9-A10.
135. Weber, L. J., J. K. Mcbee, and J. E. Krebs.: 1983. Take home tests: an experimental study. Res Higher Educat. 18:863-483.
136. Welch, G., K. Pearce, M. Lewis and G. Mellsop.: 1990. Adverse learning strategy: the Adelaide Diagnostic Learning Inventory and its subscale replicability in a medical student population. Med. Educat. 24:117-123.
137. Weinberg, NS.: 1989. The relation of medical problem solving and therapeutic errors to disease categories. QRB 15:266-272.
138. Wergin, J. F.: 1988. Basic issues and principles in classroom assessment. In: "Assessing Student Learning", MacMillan, JH, ed., New Directions for Teaching and Learning no. 34 Jossey-Bass, San Francisco, CA. pp. 5-17.
139. Whitely, H. E.: 1988. 124 is enough. Intervet. 24:23.
140. Whitman, N. A., P. R. Burgess, and J. H. Petajan.: 1989. A second look at consequences for medical education of problem solving in science and medicine. Acad Med. 64:548-549.
141. Wilkerson, L. A., and G. Feletti.: 1989. Problem-based learning: One approach to increasing student participation. In: "The departmental chairperson's role in enhancing college teaching", Lucas, AF, ed., New Directions In Teaching and Learning No. 37 Jossey- Bass, San Francisco, CA.
142. Zemke, R.: 1990 (Mar.). Storytelling, back to a basic. Training, pp. 44-50.

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August 10, 1995

TO: Dr. David Balk

FROM: Dr. John A. Pickrell

RE: Response to evaluation of Santos, Susan and Balk, David E, ***Evaluator analysis of interviews conducted by John Pickrell (and Candace Layton), July 1995, Received 7/31/95.***

INTRODUCTION

This study was conducted paralell to the FIPSE study, but had some results which bear directly on those of our evaluators, adding new information and presenting at least one opportunity for triangulation. *Teaching Partners* are neither common, nor especially rare throughout the country. To our knowledge, this partnership was unique in coinvestigators of this study. Additionally, by asking general questions it provided general information about our student population which was of interest to our coinvestigators. Finally, I'm not certain that all the features of this unique program are immediately apparent. This response presents additional information for our evaluators to consider. As always, we welcome additional responses in synthesizing our final report.

METHODS

The analysis is of formatted interviews from principally Junior and Senior Veterinary Students as part of a *Teaching Partners* project. Teaching Partners is inspired by Joseph Katz's program for New Jersey Master Teachers (Katz J, Henry M, 1993. *Turning professors into teachers*. Oryx Press, Phoenix, AZ 173 p.) and expanded throughout the US, mostly by Steve Golin. Dr. Layton, a soft tissue

surgeon and I first encountered it at a Kansas City Regional Council for Higher Education (KCRCHE) of which Kansas State University is a member. I presented some work in PBL at a later meeting for KCRCHE and at a KCRCHE Master Teachers Workshop. Teaching partners have these goals.

1. Find your teaching partner, bond based on the mutual goals of improving your teaching. Teachers of approximately equal abilities will find the pairing more productive. Teachers should be at the same or a close institution, but need not be in the same content area.
2. Prior to class, find out what your partners goals for that session are and use class response to indicate what was going on. Your partner must take your, her/his data and decide if these goals were met.
3. Attend 3 of each others class meetings, lectures, discussions or case analyses.
4. Interview at least 3 of your partners students and ask them what your partner could do to improve her/his teaching.

We may constitute a unique use of this program since we shared the same students. Thus, both interviewees interviewed their own students. We suggested to our students that they be interviewed by the person they wanted to correct the least, so that they would feel most at ease. Most students did not seem to mind, because they were talking to their instructors, who were spending their time with them in what must have seemed to the students to be a serious effort to cocreate a new course. In addition, neither Layton or Pickrell were regarded as being especially threatening. Finally, their didactic instruction by Layton and Pickrell were completed and they were less nervous.

Secondly, the students were interviewed at the end of the course, when midcourse corrections were no longer possible. Data was valuable supplement to written TEVAL evaluations for any potential changes in the course. Katz and Golin make it clear that more benefit would be derived by interviewing the students during the time of the class. Certainly, the detail would be clearer, but students would lack the perspective of those successfully completing the course. We continue to consider

how best to implement this (Dr. Layton has returned to private surgical specialty practice; Dr. William Fortney is partnered with Dr. Pickrell).

As summarized by Susan Santos, the responses were coded and categorized by themes. The answers had multiple components for some students (the evaluators assumed that the questions had the same components). Actually, our evaluators instructed us to ask the questions in open-ended manners so that we elicit as much information as possible. The interviewers tended to allow students to skip and subsequently eliminated questions for which uninformative or no answers appeared to be emerging. The multiple components of student answers were so informative that they were formalized into questions for later surveys.

The survey is divided into 2 sections, general, applying to veterinary school and special, applying directly to the courses of Layton and Pickrell. In some cases, the answers to general questions about veterinary college would define several populations who might have responded differently. Our observations are that the response to general questions had little to do with responses to specific questions One must remember that these students were chosen randomly from students willing to participate (usually > 50% of students). We owe students a debt for being willing to take their time and share their views with us their instructors.

RESULTS AND DISCUSSION

PRACTICAL EXPERIENCES: Students knew early in life that they wanted to attend veterinary school (52%), because they like animals (23%) and wanted to be a part of the community (10%). **Practical (hands-on, real-world) experiences** were most likely to verify that students expectations for veterinary school had been met (most common response; 28%), were regarded as something which should be done in instructing them, reflected what they felt to be their best learning style. Half of the students regarded hands-on experience as their best learning experience. They felt case-based (problem-based) learning (toxicology and surgery; intermediate response 14%), visual instruction or surgery and videotapes (both) were good substitutes for hands-on learning. Two factors are apparent from this analysis: Although practical

learning was popular and regarded a strength of this teaching partnership, occasional students wanted still more practical, hands-on or case-based learning. Secondly, had students been allowed to design their own experiences, they would have been very heavy on practical or hands-on and weak on theory, content or medicine and surgery.

Clearly from their comments, and the comments of our evaluators (Susan Santos and David Balk) students may not understand the utility of theory. We note that alternatively, the students may believe that if they work side by side with someone who understands more theory than they would ever want to know that the conversations with those clinicians will somehow rub off and be incorporated into their knowledge bases. In this case, they'd probably like to see how the specialist clinician uses that theory. (We note, that this line of reasoning closely approximates the justification for apprenticing that was used prior to education in veterinary colleges.) This survey does not distinguish between these alternatives. The evaluators Susan Santos and David Balk have discussed the first one at most length and we partially support their reasoning regarding these student recommendations. Our veterinary college as a whole believes that students need both. Thus, we give them 3 years of mostly didactic lecture-based instruction and 1 year of clinical instruction. Our licensing examinations reflect this division of education by requiring them to pass both a national board examination, based mostly on their didactic instruction and a clinical competency test. The pass rate nationally and at Kansas State University is very nearly equal for both tests at mid senior year ($>80\%$). It is clear that the issue of theory must be incorporated into practical veterinary medical-medical experiences throughout the professional education. Our study is one of several (**Medicine:** Albanese M, Mitchell S, 1993. Academic Medicine 68: 52-81; Barrows HS et al., 1986. Med Teacher 8: 325-331; McAuley RG, Woodward CW, 1984. J Med Educat 59: 842-843; Normal GR, Schmidt HG, 1992. Acad Med 67: 557-565; Wilkerson L et al., 1991. Acad Med 66: S79-S81; **Veterinary Medicine:** Cornell Program—Cornell Veterinarian; Mississippi State Program and others—PBL in Veterinary Medical Education: Challenges in Implementation—March 2-4, 1995, San Diego, CA) viewing the problem from different perspectives. To my knowledge, the

challenge of balancing practical hands-on training and theory in the medical field remains to be solved.

Theory, or a complete understanding of mechanisms is frequently of use in cases which are especially difficult or complicated, or in cases which there is as yet no adequate therapy or surgical correction. The art of practice is replete with the values, insights and concepts which help students organize the vast amounts of new knowledge which pours into them every day of their professional lives. K Patricia Cross has said, "Education is what remains long after you've forgotten the specific details". Students agreed with this statement (15/15; 100%), and provided examples that indicate they are beginning to understand that theirs is more than just a technical education. Numerous direct quotations in this summary indicated that they have faith in their instructors, specifically these teaching partners giving them the technique, art and values of practice. Alvin and Heidi Toffler tell us that our knowledge architecture (capacity; what you know and what you can do with it) is our graduate's most salable product and that diversity will drive our future accomplishments. They say further the progressive apprenticing (our equivalent is hands-on training) will do far more good that money or labor in building our country's (we read profession's) achievements.

GROUPS: Our veterinary graduates will be involved increasingly in **team consulting** and cocreating optimized health care for their patients. Frequently (25%; most frequent) of veterinary students surveyed recognize that some diagnostic and management problems can be of incredible complexity and difficulty and have already begun to use consultation to surmount those difficulties. Most felt any information about how to solve difficult or complex problems would be a valid addition to our courses. A larger number **learn in groups**, a form of intrastudent consultation—21% identified it as their best learning style. 30% (most frequent response) use groups as their predominant method of study, while an equal number studied alone. Students tell us that groups allow students to support and help each other with their most difficult assignments. Interactive learning, where students and instructors partner

briefly, was frequently cited as helping students learn in toxicology and surgery (41%), as opposed to good outlines (14%), written cases (14%), minilectures (14%) and "not talking down to them" (10%). In fact, 18% of students (5/28) asked that we place important or common toxicant/surgery cases in the library so that they could study them.

Team learning is thought to be the one of most powerful learning currently being practiced (Senge, P et al. 1994. *The fifth discipline fieldbook*, Currency, Doubleday, NY). In Veterinary Medicine and Medicine we practice this as group study from a variety of classes, cooperative learning, lecture-, case- and problem-based learning, and small group problem-based learning. Teams are formed with mutual respect, and discussion of growing skill and some dialogue or brainstorming is used to learn subject material which would have been more difficult individually. Students have growing skill in expressing their complex results. Advantages of this technique are thought to foster continuation of study groups. The structure of small group problem-based learning supports most of these steps. Although groups are randomly assigned (as in cooperative learning), in many cases, because of intensely successful working conditions, profound respect and new contacts develop. **By way of comparison,** the orchestration and shortened intragroup discussions of **large-group problem-based learning** may reduce consistent development of skill in discussion, brainstorming and dialog, although some groups do acquire most skills and learning. **Hybrid lecture-large group problem-based learning** preferred by a previous evaluator survey will shorten intragroup discussion still further, but summarize student-instructor interactive findings more completely.

SUPPORT: Students especially appreciated **the support** provided them by Layton and Pickrell (7/7; 100%), especially in not being intimidating and supporting them even when correcting them. All students (7/7; 100%) felt they would like to be rescued without being intimidated. Students cited the support as the most important feature meeting their goals for the course with intermediate frequency (8%). Nurture helped build their confidence and more deeply involve them in the processes of

diagnoses and management and to regard their relationship with professors as one of partnership (14/25; 56%) as opposed to ambivalence (24%), antagonism (8%) or disinterest (4%). Many indicated that this was somewhat instructor dependent. Students frequently (9/17; 53%) cited being treated with respect, that the instructors really cared about them as what they liked best about the course. This support may be a factor in the high approval rate of this teaching partnership (89%) where we were trying to improve their teaching and actually asked their opinions. Several students have indicated that **beginning the senior clinical year**, where it all comes together, is the most rewarding and yet the most stressful event of their veterinary medical education. About half (49%) indicate that they expect this to be a positive response. Encouragingly, an additional 14% were apprehensive, but now regard it positively. Approximately 1/3 remain apprehensive, but expect to survive.

Nurturing (safety), education (stability) and building (precision) are 3 major components of order. These are often opposed by chaos (self determination, liberty and non-conformity [anti-cause and effect]). When safety and stability are sufficiently high, one can often ignore them momentarily and violate cause and effect to solve a problems. Without this, problems are solved much more hesitantly less building occurs (Donaldson S, 1991. *Forbidden Knowledge*, Bantam, NY). Thus, nurture is necessary for rapid student progress. Our impression is that students answer more difficult problem solutions if they feel safe and if we ask them easier questions first, to prime the pump. This appears to work as well with content as with problem solving questions. Students mention the positive effect of being treated with respect. This is a vital component of team learning (see above), and the instructor and each student may be regarded as simple teams.

CONTENT QUANTITY: Students felt that there was a **great deal of material** (content; 27%) and that it was difficult to keep up (69%). The veterinary medical curriculum is constantly expanding and what material to use is a constant consideration. Students suggested that the material they should learn should be reduced. They felt that being taught only the common toxicants (41%) or the most

common surgical procedures (46%) would simplify their lives; we suggest that the simplification might be temporary and that it must be carefully conceived and executed. For example, we experimented in 1994 fall with a hierarchial organization with mixed results (McKay, Toxicology during the fall semester, 1994: The fifth evaluation of the FIPSE-funded innovation in the college of Veterinary Medicine, 1995). Only 1 of 2 instructors followed the proposed modification, the one who wrote it. This led to student perception of 2 different approaches to toxicology, generating significant anxiety, not present prior to this modification. More than half (74%) of the students wanted to learn to diagnose the need for common surgery better. Finally, students indicate knowing the common diagnoses uncommonly well, especially including the common differential diagnoses were invaluable to them.

EXAMINATIONS: Most students believed that the **purpose of an examination** was to find out if the students were where they were supposed to be with respect to course material or to assess what the students had learned. One perceptive student felt that instructors and students would both learn by the examination; we agree. Another felt that they reflected back on us—that we were known by their quality; we agree. Neither I or the evaluators noted that students thought they could learn by examinations. However, I (JAP) see some evidence of this. For example, students **check their progress** (daily, course, year and veterinary practice) by self tests (50%) and official examinations (36%), although they are somewhat ambivalent about the latter. Secondly, they favor **oral examinations** (35% would increase their number in the examination schedule [most frequent response]; 35% felt that Dr. Layton should use them like Dr. Pickrell did [most frequent response]; 12% liked them best about the 2 courses and 11% suggested their increase as a curriculum revision [responses of intermediate frequency]). Students tied their preference for oral examinations to their ability to learn from them and integrate the information that they were already taught. We believe that the stated factor was important. However, we have recently learned that undergraduate students believe grades should include some effort component and are at least partially negotiable (Goulden et al., 1995, Kansas State University). Oral examinations include more than just the *correct answer*. They feel

that their score reflects not only their answer, but what they appear to be able to do with it (Knowledge Architecture; ie., hesitancy, practicality, and reasoning). It is like their experiences when interviewing as seniors. It is our impression that students feel that they at least partially negotiate their oral examination grade and that that perception is important to them, more important than it is to their instructors. Students frequently commented that instructors and students should both learn and teach in the course (62%), as opposed to the more traditional view, that students learn and instructors teach only (15%). They felt that they had learned, and occasionally cited examples where they felt that instructors had learned both from the course and from the examinations, generally the oral examinations.

Faculty perception of the purpose of an examination is to illustrate that students knowledge base relative to the questions asked; most students perceived this. If those questions relate to the desired knowledge base and to the real world, interesting events take place. Instructors are perceived as asking about questions highly relevant to those the student will need to answer. Secondly, instructors are perceived as asking questions which accurately reflect students knowledge. Thirdly, instructors learn about the students knowledge base—how well their concepts are understood and can be applied by students. Finally, instructors learn—often a great deal—about the content of the areas on which they ask the questions. Thus, the instructors learn a great deal by each examination which is rooted solidly in their course content and in the real world.

Students also learn. They learn how to respond to real-world questions, and how their expert instructors expect students to respond to those questions. They learn what they know and what they need to know about these questions to perform in the real-world. If exams are conceived of appropriate difficulty, they learn that they have learned the material very well and can apply it to a real-world situation. Thus, students learn a great deal by examinations. Students in this survey recognized that exams are a learning situation for both faculty and students, but did not provide further details to illustrate these points. Their instinctive preference for oral examinations suggested that on a different level they understood the value of learning from examinations. Their ambiguity about using formal examinations to check their

progress as opposed to tests they conceive for themselves probably related to the ready availability of self-conceived tests, the ability to understand the examiner, or possibly a spouse and their perception of the degree to which the formal examinations were rooted in the real-world and reflected knowledge that students needed to know.

Most students (71%) felt that their **examinations in the 2 courses accurately portrayed their knowledge**, as opposed to those who were unsure (19%) or felt that the examinations did not portray their knowledge accurately (10%). These data argue against the evaluation in McKay (Toxicology during the fall semester, 1994: The fifth evaluation of the FIPSE-funded innovation in the college of Veterinary Medicine, 1995), whose conclusions derived from evaluator observations in 30-50% of the fall toxicology classes. We will continue to try to elucidate the basis of this difference seen by triangulation of the results.

CURRICULUM REVISIONS: **Impromptu ideas for curriculum revision** were quite perceptive and in some cases, prophetic. These included coordinating surgery and medicine courses into systems (5/18; 28%). Interestingly, surgery is beginning this revision this fall. The medicine faculty has some support for using this idea (50+%), but is still working on the revision, which is much more complex. Students asked for an increase in hands-on experiences for their education (22%). Interestingly, an augmented clinical skills course is in its second year. 17% of all respondents asked for management and accounting classes. The Hill's National Center for Practice Management is providing these classes (3-4 years) and they are quite popular with graduate veterinarians.

INSTRUCTORS CONDUCTED THE INTERVIEWS: The design of *Teaching Partners* is such that the instructors do conduct the interviews, and their specific goal is to improve their teaching. This design has the advantage of being highly personal to the students. It has the potential disadvantage of intimidating the students, as do all *Teaching Partners* programs. The underlying theory is that instructors who conduct such programs are for the most part highly interested in students, and

generally not intimidating. We made a significant effort not to intimidate and would have not gone to this work if we were not highly interested in students. The evaluators and everyone who has looked at preliminary results of this study have raised this question. We agree that it is legitimate for *Teaching Partners* across the country to continue to consider it.

INCONSISTENCY IN THE NUMBER OF ANSWERS FOR THE QUESTIONS: To not interpret beyond the results of this study, we have excluded results from questions with only a few answers, or noted both their numbers and percent (7/7; 100%) when they were included to clarify a trend expressed by other data. In no case has a trend been primarily expressed from data of small numbers. Interview questions deleted from the set were mostly deleted by students not providing meaningful answers and the teaching partners deciding that they should not be included. Early in the project these deletions were discussed with Drs Clegg and Shroyer who helped us write the questions. Questions added were as the result of provocative answers to open-ended questions asked in previous years. We felt that the added questions might provide sufficient structure to probe more deeply into this interesting area. When we obtain sufficient answers, these data will also be analyzed.

David, as in the other evaluations, you make several thought provoking points. I welcome your response, important to the synthesis of the final evaluation.

Evaluator Analysis of Interviews Conducted by John Pickrell

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July, 1995

Evaluator Analysis of Interviews

Conducted by John Pickrell

Introduction

This analysis was done with a population of veterinary medicine students predominantly in their junior and senior year of school. There were nine students from the junior class of 1990-1991 with six females and three males. The junior class of 1991-1992 interviewees consisted of eight females and one male, the class of 1992-1993 had two males and three females, and the class of 1992-1993 had two males and five females. There was only one student (a female) interviewed from the junior class of 1994-1995.

Dr. Pickrell, a Toxicology instructor in the College of Veterinary Medicine, interviewed the students in a one-on-one setting, except for two students who preferred a joint interview. There were 11 general questions and 19 specific questions asked the participants. Several questions had multiple components. The questions focused on areas of: student characteristics, factors affecting student learning, examinations, customer satisfaction, teacher-courses, and education. It is the evaluators' understanding that several questions evolved over the course of time and additional questions were added to meet new needs.

Methodology

One of the evaluators (Santos) coded the interview responses and categorized them by themes. The questions had multiple components, some students were not asked all components, and some students would not respond to some components. The interviewer did not ask the same questions within each year group. Each student was asked at least one component of each question. Some questions not asked at the start of the study were introduced at a later date, and some earlier questions were dropped as the study proceeded.

Results

General Questions

1. Why are you going to Veterinary School?

The interpretation of the question had part of the respondents answering as if it were framed in a time context (e.g. *When* did you decide to be a veterinarian?). The other portion of the respondents actually answered the question as posed. There were 31 students who responded to this question.

Sixteen responded they knew relatively early in their lives they wanted to be a veterinarian. They used reference points such as "grade school," "since third grade," and "as long as I can remember." Two students knew by high school or early college.

The remainder of the students focused on the question as asked. Seven students mentioned they liked animals and/or the profession. Three cited their wanting to be part of the community as the reason for their decision. Three were in other

fields and transferred to pre-veterinary medicine, and three students' answers seemed to vary from the above. For example, one student indicated he wanted to combine his interest in agriculture and animals, and finally one student wanted to do research when completing the degree.

2. What is the most important way that your expectations have been met?

Eight of the twenty-nine questioned indicated their expectations have been met by the practical experiences provided them. Responses included, "I can see it and feel it and then I know what is going on." And, "I expected to learn a lot, especially the practical or hands-on skills and for the most part, our classes do that."

The next most expressed response was the indication they had been challenged. For instance, one student indicated, "It's been challenging. When I have a case and can follow it from beginning to end and I can diagnose and manage it."

Two students indicated they felt good because they had been able to survive the rigors of school. One student felt the image of the school was a positive one. Only one student felt his expectations of the school had not been met, but in the school's defense he recognized this was perhaps because he had not yet clearly defined his own expectations for himself.

2a. What is the most important way we've fallen short?

The answers here seemed to fall into a pattern depending on what year the questions were asked. Overall the students felt

they have not been given enough practical experience. At the same time, the students felt the practical, hands on experience was one of the ways the school had met their needs. (See question 2 above). This theme will be analyzed further in the discussion section of this document.

The second most frequently given responses focused on two areas. Four students indicated the following responses as ways in which the school had fallen short. They were: areas of "professionalism" and professors being "boring." Cited with lack of professionalism was behavior of both the professors and their fellow students. Examples of this behavior ran the gamut from professors talking openly about the administration in class lectures, students coming to class late, administrators not taking the student's concerns seriously, and fellow students being petty about points on an exam.

What constituted "boring" ran on a continuum from professors just standing up and reading to the students to lectures being repeated verbatim year after year with little or no change. One student commented the instructors were not "top flight." She defined a "top flight" instructor as one who "comes to class prepared, has good handouts and is enthusiastic about the subject."

As stated above there emerged a pattern of responses from the various classes. Those interviewed in the class of 1990-1991 predominantly responded that the instructors were boring or accented the need for more professionalism. The class of 1991-

1992 wanted more practicum experiences, but no responses pertained to the instructors' or classmates' behaviors. For the 1992-1993 year the respondents primarily cited the lack of enough practicum as the way in which the school had fallen short.

3. Give me some do's enabling you to learn.

The three areas students tended to focus on were: the need for gaining a great deal of practical experience or hands on learning, interactive learning, and visual learning. One-third of the 32 respondents felt they needed "real world" experience. One-third valued interactive learning and five students expressed their need for some form of visual medium (e.g. slides, pictures, etc.) to facilitate understanding of the concepts presented. For example, one student commented, "If you're talking about something, *do* let me see the slide about it. If it's a disease process, show me a slide."

Give me some don'ts enabling you to learn.

Four students expressed a desire for the professors to "not bore them." They indicated they needed not to do "bad lecturing, give too much detail, and to not intimidate them." The second most frequently mentioned response was students' concerns over getting too much detail. One student stated, "Don't give lots of minutia..." and, to paraphrase another student, two or three names for things would be sufficient instead of five or seven.

In reference to bad lecturing one student commented, "Don't use profanity...In lecture I think they could get away from it. I can't say that I actually learned much from that type of a

teaching situation. It turns me off. I don't think it's just me".

Another point made by the students was that small group interaction needed a facilitator in order to succeed. Some students noted they preferred not to have instructors with "bad attitudes." Finally, there were individuals who expressed the following: not dropping lecture as a modality of teaching, not leaving the students without a picture, and not having case-based medicine. Specifically concerning the desire to forego case-based medicine the student provided an example by saying, "Don't teach case-based medicine like...She went from material to case, just when you were grasping it, and then back and forth so many times that it was really hard to take notes."

4. Think of a time when you thought, that learning just couldn't get any better. Please describe. (Relate this to an especially meaningful course.)

Fifteen of the twenty-nine respondents mentioned some form of hands on experience where learning was most meaningful. Again in praise of the hands on experience one student stated, "...we got to do tracheostomy, thoracotomy tube in recently euthanized dogs, open the chest and do cardiac massage. Videotapes approached this, but hands on and small groups really does it for me."

Three felt the use of visuals as helpful in the acquisition of knowledge, and two felt it helpful when the teachers are motivated and want to be there. Single responses were made of

the following: the use of good handouts, learning from mistakes, good organization of a course, learning by teaching, and problem-based learning.

4a. Did you feel that way in either of our courses?

When the students related this question to surgery and toxicology courses the majority responded that though they liked the problem-based learning technique the more hands on the nature of the course is the better they enjoy it.

One student reflected, "Both classes had a lot of things I liked. Toxicology was hard. I read the assignments, but sometimes they didn't prepare me for what I ran into. In surgery, Dr. Layton gave us this outline, and we didn't have to read it right away. It was hard to go back to toxicology case (sic) and try and explain it. We could ask anything that we wanted and it was a lot of dialogue and that was good."

Another student expressed his need for hands on experience over the problem-based learning like this, "No, remember, I need live animals... your cases are closer than didactic lecture and videotapes closer yet, but not the real cigar."

5. What is your best learning style?

One-third of the responses were consistent with the pattern of practical, experiential learning identified above. The students felt their best learning style included some form of hands on training. Six of the twenty-eight respondents stated some form of group setting helped them learn well as indicated by

the following comment, "I learn best be studying in a group. For me it has to be a small group."

Problem-based learning was specified by four of the students as their most optimal way to learn. One student in the class of 92-93 related his experience with problem-based learning by the following comments, "I learn more from problem-based learning...This year's rotation was preferable to last year's clinical toxicology. The instructor can guide you."

Three other types of learning were named each by two students. They were: visuals, good lecture, and good organization. One student indicated the need for the course to present a challenging environment, and still another felt interaction with the individual instructors to be the best way to learn material.

6. Someone has recently said to me, that learning difficult material, or solving difficult problems is hard. How do you attempt to answer these problems?

The students' responses were multiple and varied. The use of rule out lists was included in five of the twenty-five respondents' answers. Comments that focused on the eclectic approach include, "I use consults frequently and work through a rule out list." And, "I do use laboratory data, consults, rule out list and even mind set."

The use of consults (instructors or fellow students) was mentioned by five students as well. Generally responses of the students tended to signify their intense scrutiny of the problem.

The problem solving process seemed to have them use multiple resources to get the job done. One student's answer held multiple responses. "Chip away at the problem a piece at a time. Redefine. Keep looking. I learn by reading. Then I'd call somebody. I like to solve the problem myself, then I can use it again".

6a. Would it help you as students if at the start of toxicology we talked a little about how you were going to run into prelims which were going to be difficult, but not impossible to solve, and I thought it might be important to tell you how to go about solving them.

All but one of the students thought this would be a positive addition to the toxicology course. Only one student felt that explanation wouldn't be helpful but did not elaborate.

6b. Unrelenting instructor support facilitates instructor-student interactions which shape your capabilities. Do you agree? Can you provide an example?

All of the seven questioned here agreed with the comment. Their reasons varied but predominantly focused on the support this provided them. One student stated, "Agree...lots of examples made me feel more confident...important because then I felt that people cared." Another commented about effects on confidence "if the instructor is not excited or motivated...then it's hard for you to get excited...in radiology teachers are open minded, listen to questions, seem to enjoy working with students even if repetitive questions are asked."

7. What do you view as the purpose of an examination?

The responses varied but most focused on the exam being a time for students and the instructor to know if they were "where they were supposed to be," or to assess what they had learned. One student even insinuated it was a learning process for the instructors as well. "I think it is to see if the student is grasping the material (and whether you are getting your ideas across). Will they go away with the material, being capable or competent of using that knowledge in practice or surgery...It also does something for you, because we reflect back on you and what you taught us (you are known by the quality of the students that you produce)." Another student coupled his serious response with a bit of humor. He stated the exams were, "To check that each student has a minimum data base to go to the next level...or maybe to give us ulcers."

8. Are students and instructors partners, antagonists or disinterested parties in examinations (Can we see each other from the other's point of view)?

Fourteen of the 25 respondents felt the relationship was one of partners. "I think they are partners. I think that's the way it should be. The instructors are here to teach, the students here to learn. That binds them together right there" was one student's comment that effectively summed up the others' responses.

The second most frequent response (six of the 25) was that there was a mix of how the students perceived this relationship.

In other words they felt they were partners sometimes, at times antagonists, and at times disinterested parties. Most of the six indicated it was instructor-dependent, citing their claim with phrases like,"...depending on the instructor," or, "...I think it depends on the instructor." Two respondents felt the relationship was strictly an antagonistic one, and still another student indicated that the relationship was primarily one of disinterested parties. Little elaboration existed to explain the last two categories of responses, but the students indicated the antagonism or disinterest was dependent on the instructor.

9. How do you study for an examination (groups, individual, keep-up or cram {24 hour recall, 48 hour erase})?

Almost one-third (nine of 30) of the respondents indicated group work was their predominate way to study followed by eight responses indicating they studied by themselves. As for the cram or keep up issue there was a mixed response. Six felt they crammed, and three felt they did both.

A pattern emerged when you looked at the responses sorted according to "year group." In year group 90-91, eight of the twelve students indicated group work was their preference. None of the eight students in the junior class of 91-92 cited group study as their preference. Their responses mainly ignored the way they studied best (e.g. individual or group) and focused on the cram or keep up issue. Their answers were mixed with three stating they used both the cram and keep up methods and two who primarily crammed. Three felt they studied best as individuals

and only one of these students reported keeping up all along. Again, none of this class stated a preference to study as a group, but one individual did report studying in a group *after* studying alone around 24 hours prior to exam time.

Out of the nine students in year group 92-93 four indicated a preference for individual study. Only one chose group study, and one indicated liking to study with a small group *after* studying alone. Three felt they more or less crammed for the exam, and two felt they tried to keep up.

The one student in year group 94-95 indicated her primary modality is to study alone. She did indicate she studied with a specific person sometimes prior to examinations. She did not respond to the issue of cramming or keeping up.

10. How do you evaluate (check) your own progress (daily, course, year, veterinary medicine)? How will you corroborate your estimates of that progress?

Half of the respondents (n = 14) felt they administered various forms of "self tests" such as the ones offered here from the interviews. One student said, "The best way for me to evaluate my progress is when somebody is speaking to me or they're lecturing, if I know something about what they are talking about, then I figure I have learned something." Another student commented, "I test myself. I read my journals and see if I really understand the material."

Five students used the official examinations to gauge their progress. One student commented this was indeed how he checked

himself but offered ambivalence at this approach. "The worst way is to check your grades when you get them back on the test, and that's how I do it. This is frustrating."

Four indicated they did not know how they were checking themselves. Comments that reflected this tone included, "I don't think that I have solved how to do this" and another said, "I haven't a clue. I really try, but don't get too far." Still another responded simply, "I don't know."

11. Is the teaching partners program in which Dr. Layton and I work together to improve teaching with your help meeting your needs for education? How specifically has it helped you learn? How do you feel about this cooperation?

A resounding 24 of 27 respondents felt the program met their needs. Two did not answer the question as posed. Mostly the students said these instructors were not just "putting in their time." They saw this program as very positive in their education. Comments included, "All the instructors need to be doing it," and "Wonderful!! You keep us (and yourselves) excited, focused and moving toward a goal."

Specific Questions

1. In what important way have your expectations for Clinical Toxicology or Surgery been met? What's the most important area for potential improvement?

Ten of the 26 students felt their needs had been met in these courses. They indicated in one form or another that they had learned a great deal. Three students felt the hands on

approach (especially in surgery) had been helpful, and three indicated the practicality of the classes had aided them in building on their knowledge base. Two students felt this type of class had given them a needed "confidence" and one indicated more confidence to problem solve. All classes responded in a variety of ways, and no pattern emerged within the distinctive classes.

1a. What is the most important area for potential improvement?

Seven students felt there was simply too much material with no clear indication of what was crucial and what was "nice to know." Several students indicated a clear frustration with the amount of material to be covered and tested on. Statements like the following indicate frustration over the workload:

"It is important for us to be exposed, but maybe it would have been more helpful to emphasize the major toxins ...that I will have to handle versus a question over a more minor toxin that I just happen to know..."

"Surgery: disappointed in the content, material overload..."

Five students felt there was a need for more surgeries to be included in the curriculum. Again, this view seemed to mirror the above statements about the sheer amount of material to be covered in one semester. One student said, "I felt that surgery last semester was a blur. I picked up on her dissatisfaction and I was dissatisfied as well."

Three students felt there was a need for more minilectures in toxicology. All three of these came from the class of 90-91.

There were four groups of two students each that offered the following suggestions in regards to improvements: a more thorough syllabus, more continuity with teaching style throughout the courses, too much material in toxicology, and less subjective grading in toxicology. One student commented everything was OK and there was no need for improvement.

2. What did the teacher do that helped you to learn?

Twelve of the twenty-nine students who responded indicated some form of interactive learning aided them in class. The more interactive the better, and the more interactive induced the students to view the instructor as involved and caring about them. They used words like "feedback," "interaction," and "questions and answers."

Four students felt the use of good outlines and written cases helped them learn while another four liked the use of minilectures. Three enjoyed the atmosphere where the instructors were "not talking down to them." They felt it aided their learning. Still another three thought the use of the quizzes helped them to learn. A final two students indicated some form of visual aid was helpful. One response was indiscernible.

3. Do you think it is important that the majority of surgical diseases or specific toxicities are actively discussed (as opposed to having assigned reading) in class? If so, how do you envision teaching all of these topics in the allotted time?

Almost half or 13 of the twenty-eight students who responded felt the need was there to just teach the common ones or the most

important ones and if time allowed the others could be explored. Some students (five) indicated it would be nice if the important cases would be placed in the library and made available to them. Three indicated it would be nice to use toxicology as a model and try and discuss them all. Two felt the use of good notes supplied by the instructor would help in this endeavor, and one student envisioned learning the copious material by hands on experiences.

4. Good surgery is considered to be an art. What fraction of the course teaching you that art should be devoted to the veterinary medical decision making process (diagnosis), as opposed to an exact description of the surgery to be performed (technique)? Why?

Twenty of the 27 students felt there should be placed a larger amount of time on diagnosing, especially the common ones. Three students indicated there should be more time spent on the techniques of surgery. Two students indicated there should be equal time in toxicology on the common and uncommon ones and equal time in surgery devoted to technique and diagnoses. Two students' responses feel out as "non answers", and one indicated sophomores should do some basic steps in surgery to get oriented to the process.

5. Some people feel that it is the responsibility of students to learn and instructors to teach. How do you react to this feeling?

Sixteen of the 26 respondents felt both the teachers and the students should do both. One comment summed up their sentiments, "Don't box us. Instructors and students can do both." Four students agreed with the statement as presented in the question. In other words they felt it was an accurate portrayal of the relationship. There were three responses that seemed to not fit the question, and one student indicated students should learn but gave no thought as to the role of the teacher. The responses were spread evenly across the groups.

6. What suggestions do you have to make it even easier to learn, or for you to learn even more of what will be practical to you in your practice?

Almost one-third or seven of the twenty-two students responding indicated it would be beneficial for them to have more hands on or practical experience. They prefer learning by doing. For example, "More clinical skills or hands on...as juniors we should be in clinics half days...then we won't stumble over the paperwork".

Six students felt there was a need for more case studies and problem solving with the cases. This thought ran in all year groups. Two students each replied the following would help them in their practice. They were: more minilectures, more tracking, and providing challenges to them. One student stated there needed to be an effort to better organize the material and provide a better syllabus. One indicated the teachers should not put them down, and one had no idea.

7. What did you like best about the teacher or course?

Nine of the seventeen students responding indicated in one form or another they felt the instructors treated them with respect and/or really cared about them as individuals and students. Comments like, "Some teachers are interested in what they teach, you in what we learn" seemed to be echoed throughout their answers.

Four students felt the minilectures were advantageous. Two liked the oral exams, and one again indicated enjoyment of the hands on approach to learning.

7a. What did Dr. Pickrell do to improve your performance on the oral exam? Did it help you learn more toxicology, or were the questions just easier? Did the graded difficulty help you to learn more, or perform better?

Only six students responded to the question. Three indicated he helped them get started. For example, one student said, "Getting started on the oral examination is the hardest part...making me feel like I'm on the right track helps...". One student felt that Dr. Pickrell did not help his performance, one indicated he helped by not being intimidating, and one had no opinion.

7b. How important is instructor support to you as a discussant in clinical toxicology? How can we make you feel more supported and allow you to make your mistakes "with a net"?

All four of the respondents felt it was very important for the teacher to support them. Only two gave suggestions as to how

best this can be achieved. They were: to not be intimidating, and support them even when correcting them.

7c. Everyone makes mistakes. How would you like to be rescued when you make your next one so that everyone knows the best answer?

All seven of the students felt in some way they would want to be rescued by someone who was not going to yell or intimidate them. One added the teacher could also do this in a polite manner.

7d. How important to you was following the seven features of a clinical cases?

The seven features of a clinical case are: identification of the problem, listing of possible diagnoses, clinical testing to be performed (e.g. lab, x-ray, etc.), diagnosis or confirmation, initial treatment of the problem, prognosis, and client education. Others features may be important such as environment and sources, but the seven above are crucial.

All seven students responded they felt the seven features are important. One added that the addition of rule out lists would be helpful, and one indicated the seven features helped give her structure.

8. What did you think was an area for potential improvement?

The responses were varied and more evenly distributed than previous answers. Students seemed to have diverse views about improvement. Specifically four of the sixteen students responding felt in some way the tests were too difficult and

needed to either have fewer cases on them or more time to take them. Three students liked the idea of having more cases presented to them for clearer understanding of the concept being presented. Two students in each of the following indicated their ideas for improvement. They were: more hands on, staying on track or keeping focused, and giving the student a mental or physical picture to work with. One felt improvement could come with teachers not reading slides, one liked Drs. Pickrell and Layton's approach to teaching, and one wanted the teachers to push them more.

9. What is your perspective about this course or teacher?

Twelve students answered this question, with 10 indicating satisfaction with both of the courses. No delineation was made by the students in regards to their liking one of these courses over the other. Grouping of the two courses (surgery and toxicology) seemed the norm. Comments such as, "Overall very good, I enjoyed both," indicated the students saw the style of these courses as similar and felt free to respond about them as one. Two students indicated they felt they had answered this question with their answers to other questions.

10. How do you think or feel about the course-teacher?

Eight of the students again indicated their positive feelings about these courses and again no delineation of the courses as separate entities. One answer was interpreted as a negative response because the student indicated feeling put "on

the spot." And one simply repeated the question and didn't answer it.

10a. Did you have a lot of trouble giving up your opinion once you had formed it?

Twenty-four students answered with greater than half of them feeling they were able to give up their opinion once it was formed. Many qualified this response by indicating in some way they needed to be persuaded by valid information and facts before they would do so. Six students felt they could sometimes change their mind depending on the situation, and three stated they found it difficult to change their mind once they had decided about something.

11. What are the benefits (of these courses) to you?

Four of the nine students felt the benefits included the ability to problem solve and organize themselves. Four also felt they had learned a great deal from these courses. One simply stated the style of going over the cases instead of lecturing was more desirable for them.

12. How can we make it a learning experience for the faculty as well as you?

Of the fourteen students who answered the question, nine of them felt the teachers could learn as they taught. Three did not answer the question, and one believed if the faculty had access to surveys such as this they could benefit from it.

13. In this course, how often do you read the texts?

This was divided into the toxicology and surgery texts. For toxicology eighteen of the twenty-six students indicated they read the text, but there was no clear indication of the readability of this text. For the surgery text six students indicated they read it, one did not, and eight read her notes more. Their comments were most flattering about her notes. Most preferred them over the text.

14. Did the examinations in this course accurately reflect what you had learned?

Fifteen of the 21 students indicated they felt the exams reflected their knowledge. Four were unsure, and two did not feel it was an accurate portrayal of their knowledge.

15. If you were in charge of the universe for fifteen minutes and asked to design the ideal examination situation, how would you change from what was done in this course?

It was not easy to tell exactly how the students felt about this issue. Eleven of the 35 respondents felt the oral exams were positive, and four indicated that within this context the case histories were good. Summing up the views of the merit of oral examinations a student commented, "More orals would be especially helpful, they helped me to learn the most of any examination. Written examinations are a poor substitute, but essay exams were good too." One student felt the use of performance exams were "the way to go."

As for the design and frequency of exams, few students responded to this portion of the question. Two students felt the

number of tests were too few due to the volume that was covered at each exam, and one student didn't like multiple choice citing they were, "deceptively simple."

15a. Curriculum Revision?

Five felt there needed to be more organization within the courses, but one disagreed. "Grouping systems together (or coordinating lecture-discussions so that all of one system is covered) during one period is probably not a good way to go. After six weeks of lung or heart, I'd probably be sick of hearing about it and not pay too much attention."

Four felt there could be an increase of hands on experiences provided them, and most did not elaborate on how this could occur. Two students felt that oral exams should be increased across the curriculum and three felt a need for management and accounting classes would be advantageous since most will be owning a small business themselves through their practice. One felt there was a need for more surgery time and two others desired less neuroscience within the curriculum. Finally one student indicated he thought it a good idea to let the students stand up after 20 minutes of lecture like one professor did.

16. A prominent educator has said Education is what remains after you've forgotten the specific details. What learning will "stick to your ribs" from clinical toxicology or surgery?

All of the fifteen students either overtly agreed with the assertion or within the essence of their answers indicated they considered the statement to be true. All felt both of these

courses had given them something to "stick to their ribs". One student gave an example for each course of what she had remembered. She said, "In toxicology, we got the terminology and where to look it up. Some common toxicants. I'll always remember nitrate is brown and cyanide is red. Just the specific procedures that Dr. Layton has taught us that we might be able to do almost in our sleep."

17. What do one of us do that the other one might benefit from? Where, indeed, should one put the minilecture?

There was very mixed response concerning the question, and some students did not answer it as posed. Ten of the twenty-eight students felt the minilectures were important and the oral exams were positive. It was difficult to tell who the students were talking about with some of their responses. Specific input from one student indicated that Dr. Layton had the students react faster and this could help Dr. Pickrell. They also thought the use of Dr. Layton's hand outs would benefit Dr. Pickrell. For Dr. Layton one comment was she needed a better room and if she had more time she could do more group work.

17a. The organization issue?

Twelve of the twenty-three students gave their impression as to how and what would constitute better organization for them or the course. The responses varied from personal approaches to more global ones. They were: summary sheets, coincide surgery with medicine and maybe even toxicology, do all of one system and move on (e.g. GI, etc.), charts, take a little at a time, ordered

the reading, [that is, the student gives different priorities to what she has to read], organize by signs, help us tie it together, read notes and cases, examples would help, we have to organize ourselves. Seven students had no problem with the organization in either course.

18. When extending common diagnoses to the more complex or difficult ones, what similarities can we build on, and what unique differences do we need to learn how to handle to make competent medical decisions?

The answers were as varied as the students themselves. Three did indicate the use of minilectures would help them in the future. Some students seemed not to answer the question. The following answers are some suggestions from the students themselves.

"There is no substitution for clinical experience."

"If you know the common stuff very well, you will have a model of the common stuff and you will see it not fit."

"I pick out the big differences to help me to differentiate."

"First you need to recognize there is a problem. You need to list the more common differentials, don't chase the zebras, keep them in mind but focus on the common."

19. Senior multimentoring, and to a certain extent clinical toxicology and surgery may be viewed a beginning to engage in a two way conversation between student and teacher. How does this engaging in this process make you feel?

Seventeen of the 35 respondents indicated in some way this was a positive experience. Five signaled some apprehension with this at first but with time this eased.

Discussion

The general questions one through 11 seemed to focus on information that students in this type program could answer with some degree of expertise. They were questions that explored their background before school and elicited information about their preferred learning style and examination preferences.

The second section of questions were more specific to the classes in question (e.g. Surgery and Toxicology) and the program in general. They were thought provoking and somewhat philosophical in nature. One might question the merit of having students at this level critique a program when they have little on which to base a comparison.

As a case in point, consider the constant referrals to more hands on work desired by the students. Many students in fields like veterinary medicine want very much to "get on with it" and perform tasks associated with the profession. It takes the professors' diligence and patience to reinforce that along with the practical work involved also comes the theory.

The students recognized a positive part of the program (question 2, general section) as the hands on experiences given them and in the very next question stated the way in which the program had fallen short was with the *lack* of hands on experiences. Findings such as these indicate the students'

knowledge deficit of what goes into the making of a professional medical practitioner. If they were to design the program one would have to be concerned their design would be no more than a vocational/technical school environment steeped with much practicum and little theoretical base.

Another concern was the fact that one of the instructors conducted the interviews. This perhaps was not a problem for most of the students, but some might have considered the consequences of not responding positively about the courses or the program. The answers appeared to have been candid, but we will never know.

Finally there was the inconsistency of the number of answers for the questions posed. Not all interviewees responded to all questions. It would have been beneficial to pose all questions to all participants. The evaluators recognize the possibility that students refused to answer certain questions posed.

Discussion with Dr. Pickrell highlighted how valuable he found the information obtained in these interviews. He described the data as "rich." It is not clear to what extent these data proved useful in terms of curriculum decisions.

Some interview questions were added as the interviewing progressed. Some questions asked in initial interviews were later dropped. A varying data base proves more difficult to interpret, and the variation in questions asked of separate year groups presents incomplete responses -- even missing data one could argue -- in several instances. At the same time, the

evaluators recognize that issues emerge as a study develops, and not to respond to emergent needs is unprofessional. We do want to accent, however, that placing significance on some responses that have fewer or even few respondents does inhibit full disclosure of the themes presented and even may become misleading as undue emphasis is placed on an anomalous response.

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