Enhancing Veterinary Education: Leveraging Digital Platforms and Artificial Intelligence for Efficient Case-Based Learning

Duncan C. Ferguson, VMD, PhD, DACVIM, DACVP
Professor Emeritus of Clinical Pharmacology, University of Illinois at Urbana-Champaign
President, VetMedAcademy.org

Email: dcf@Illinois.edu and duncanf@vetmedacademy.org

For Asian Association of Veterinary Schools, November 14, 2024

OVERVIEW

- Perspective: Historical and Philosophical
- Why Case-Based Learning (CBL) and Critical Clinical Thinking?
- Didactic framework and focus on competencies
- Experience with Early-Year CBL at the University of Illinois
- Why is CBL so hard to implement?
- Digital “Extensions” of the Instructor– LMS tools and AI
- Summary

CBL IN VETERINARY EDUCATION

- Focuses on **real-world cases** to promote critical thinking
- Engages students in **problem-solving**
- **Survey:** *Have you tried it with a vet class?*

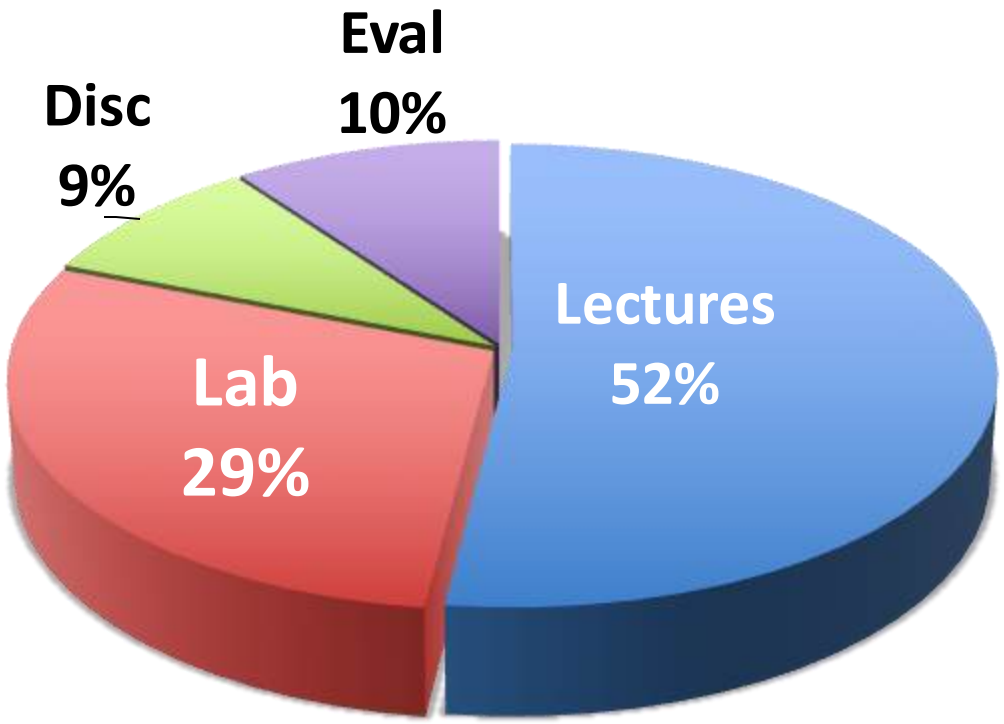
DALL-E 3

WHAT WE LEARNED FROM ONLINE CE

- **First online CE for vets** –VIN-1990-2000
- ***Practitioners applied content*** as they learned.
- ***Case discussions were more personal and engaging.***
- **Conclusion:** Practical ***application*** should be embedded in every aspect of training, as it ***deepens and personalizes its meaning, leading to longer term retention.***

DALLE-2: Prompt: excited veterinary students working together on a computer to solve a clinical case

FIRST YEAR CURRICULUM AT UNIV OF ILLINOIS CVM –2009

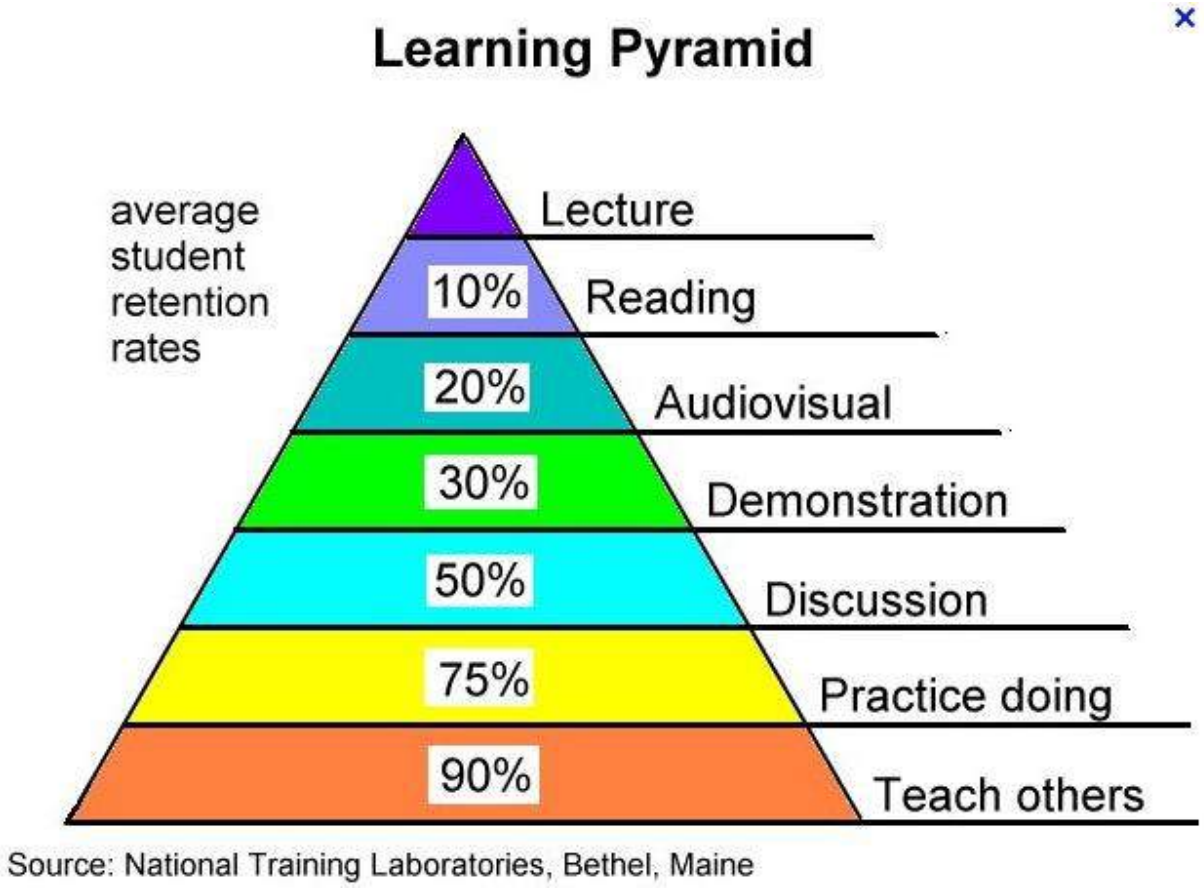


OBSERVATIONS

- **PASSIVE!**
- Integrated courses, but **poor retention**
- More **evaluation** than guiding
- Clinical Correlation sessions: initially **more content than process**
- **Conclusion:** more guidance on critical clinical thinking needed

WHY CRITICAL CLINICAL THINKING (CCT)?

- Practice and peer teaching = ***highest retention rates***
- **Decision-making** is at the heart of clinical practice
- **CCT** and **evidence-based medicine (EBM)** may engender negative reactions in practice, so it should be ***reinforced during training***



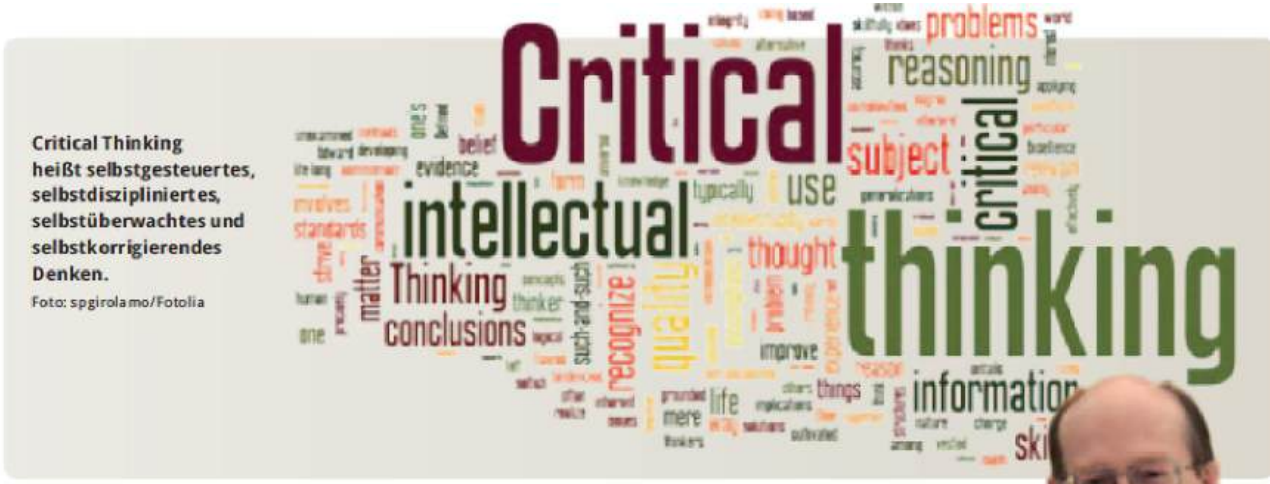
STUDENTS NEED PRACTICE WITH *CLINICAL UNCERTAINTY*

...”*not teaching clinicians about clinical uncertainty has been referred to as ‘the greatest deficiency of medical education throughout the twentieth century.’”*

Gambrill E. (2005) Critical thinking in clinical practice: improving the quality of judgments and decisions. 2nd ed. Hoboken: Wiley and Sons.

FULBRIGHT KOMMISSION

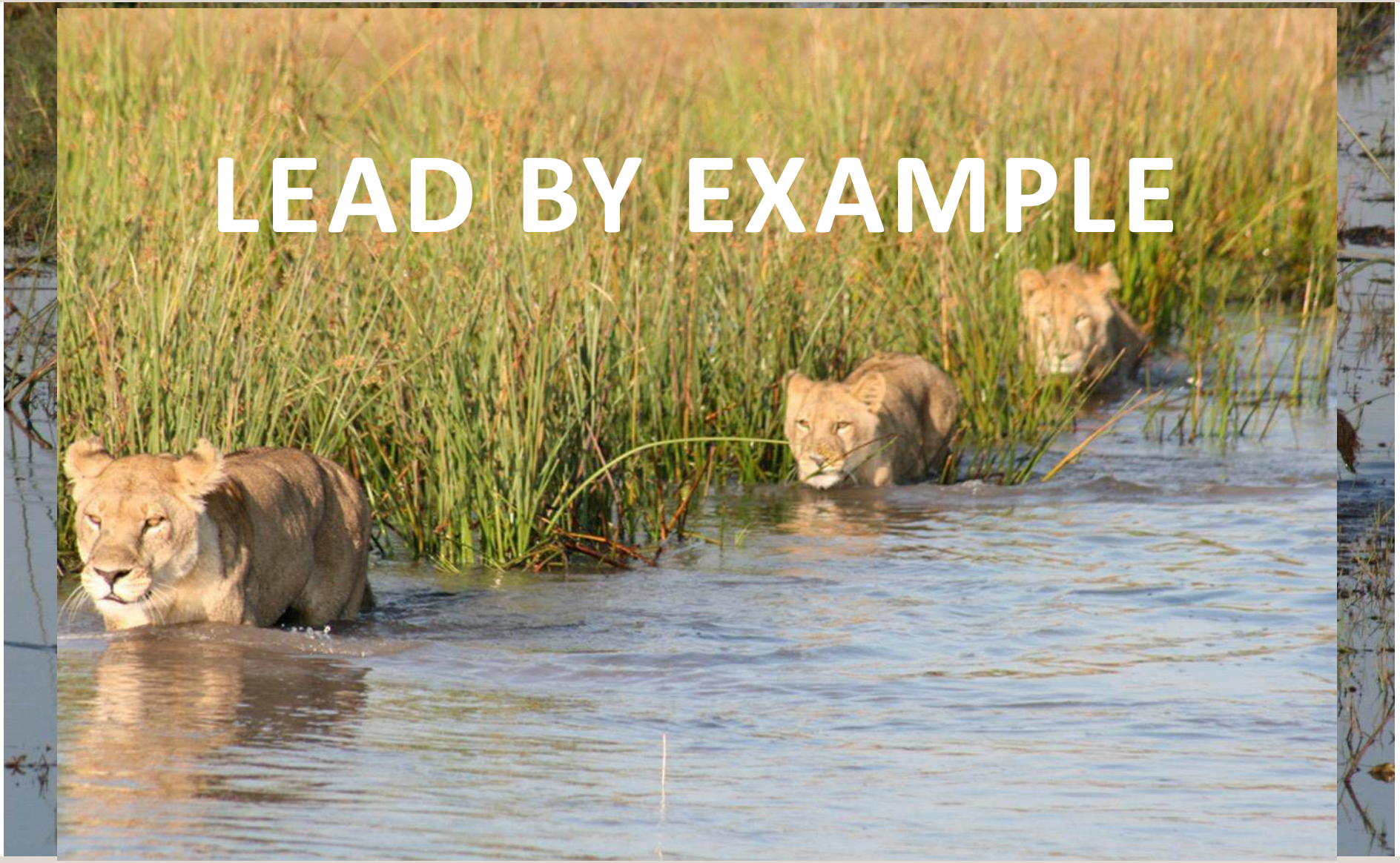
INSTITUTE OF INTERNATIONAL EDUCATION | CIES Council for International Exchange of Scholars



ANALYTISCH DENKEN

In dem Kooperationsprojekt „Kritisches klinisches Denken“ lernen die Studierenden, die richtigen Fragen zu stellen und klinische Fälle zu lösen.

Professor Duncan Ferguson, VMD PhD, von der Universität in Illinois
Foto: M. Leirer


LEAD BY EXAMPLE

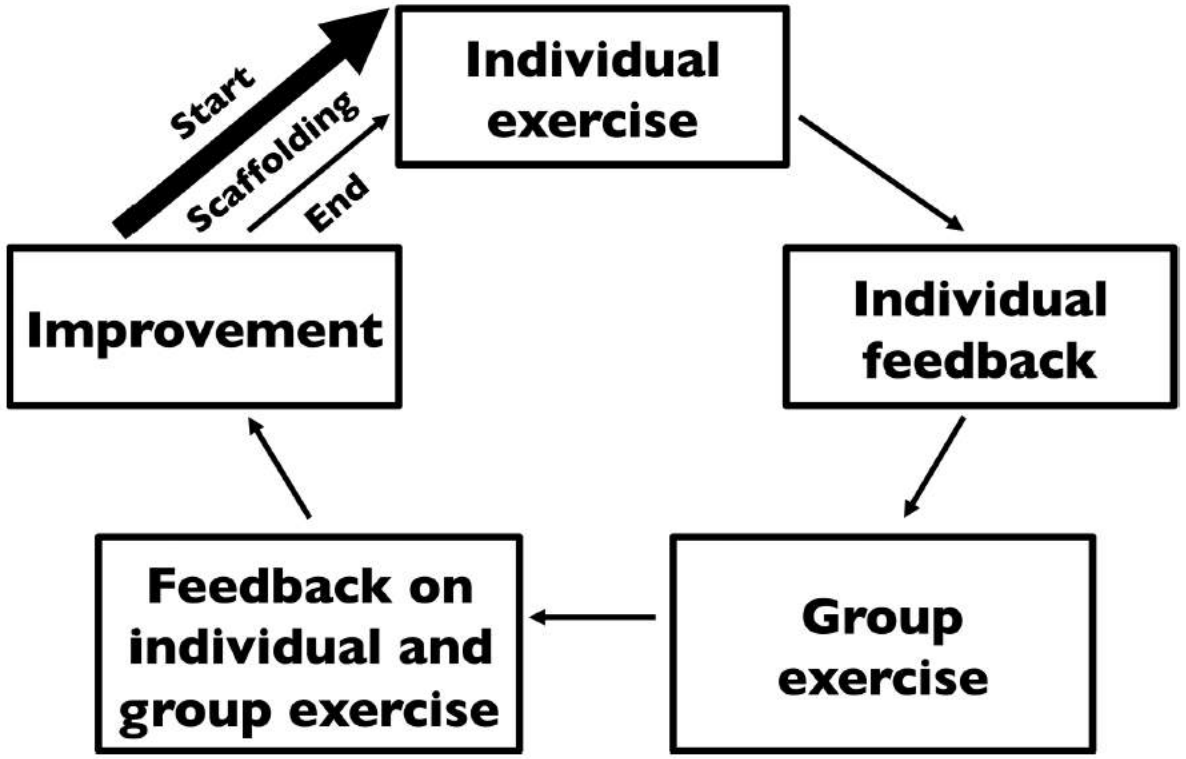
COMPARING STUDENT PERFORMANCE OVER A YEAR

Hypothesis 1: Given practice at critical clinical thinking over a year of instruction, students would improve standardized general critical thinking test scores and case analysis rubric scores

Hypothesis 2: Paired group work performance would correlate with improvement in individual scores

Ferguson DC, McNeil LK, Schaeffer DJ, Mills EM (2017); Encouraging Critical Clinical Thinking (CCT) Skills in First-Year Veterinary Students. *Journal of Veterinary Medical Education* 44(3): 531-541.

CYCLE OF CRITICAL CLINICAL THINKING (CCT) EXERCISES

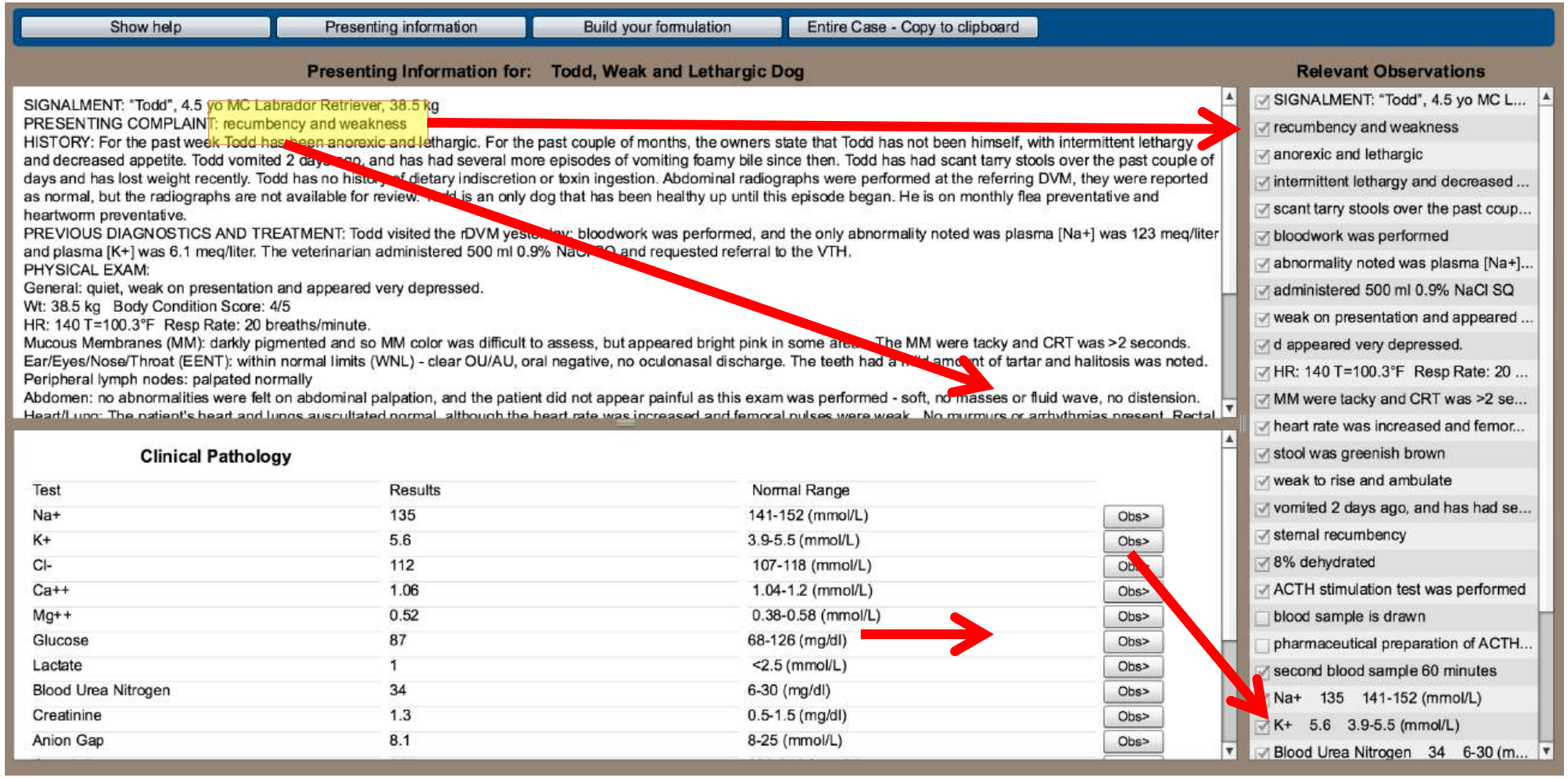


Ferguson DC, McNeil LK, Schaeffer DJ, Mills EM (2017): Encouraging critical clinical thinking (CCT) skills in first-year veterinary students. J Vet Med Ed 44(3): 531–54. https://doi.org/10.3138/jvme.0216-032R1

NOTE

- ✓CCT exercises focus ***more on process than on content.***
- ✓*However, studies have shown that exercises have greatest impact when they are* ***discipline-specific.***

ADDISON'S DISEASE CASE: CHOOSING RELEVANT OBSERVATIONS



https://www.whenknowingmatters.com/

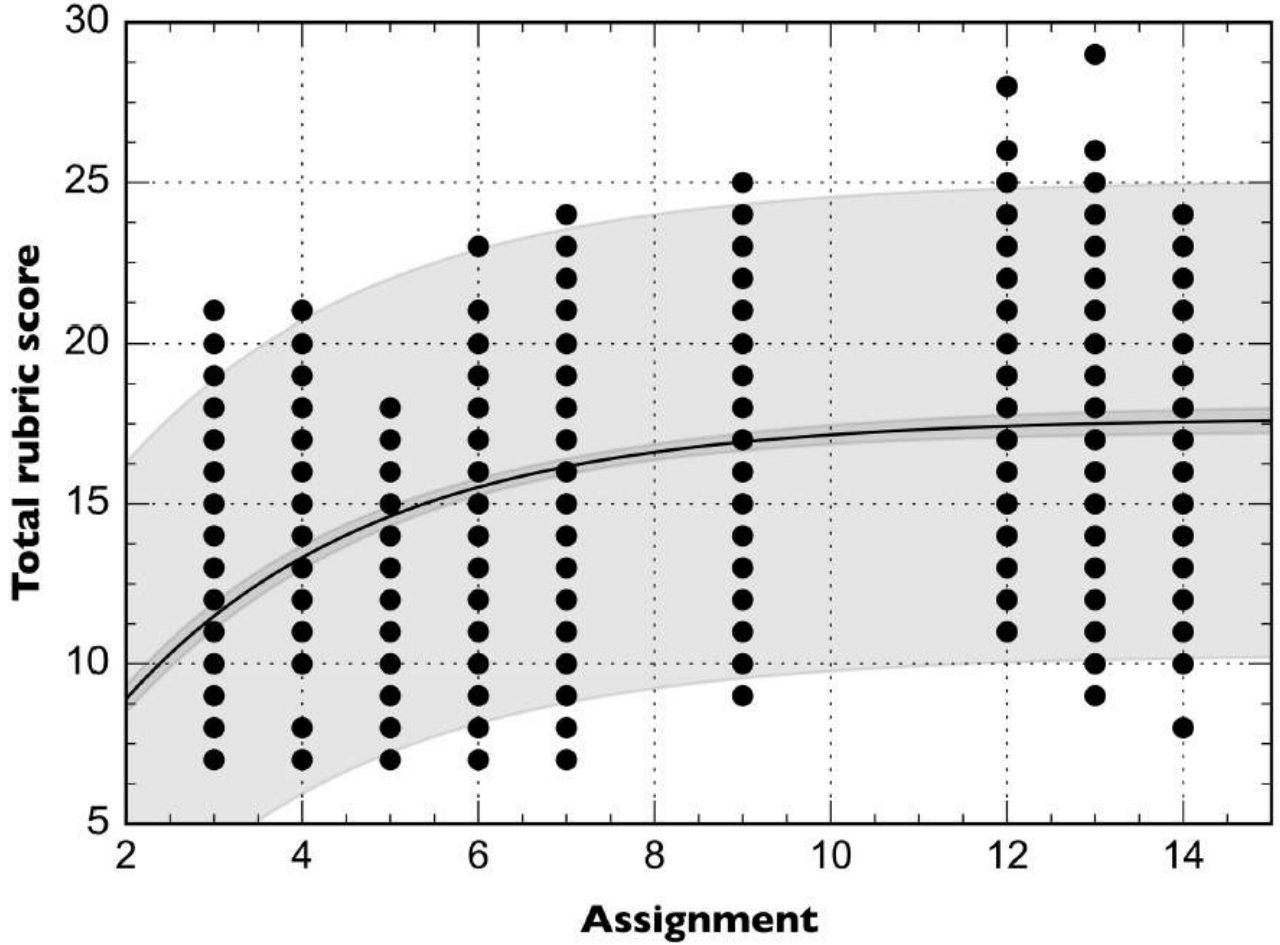
RUBRIC (USED BY FACULTY)

- *Questions*: development of refining (or clarifying) questions to answer based on an honest assessment of current knowledge base;
- *Approach*: approach to seeking answers to developed questions (e.g., literature search);
- *Judgment*: judgment of quality of information (awareness and application of standards of a discipline, bias detection including appropriate humility to detect one's own potential bias, and the application of statistical concepts);
- *Analysis*: analysis of an argument;
- *Clarity*: clarity and communication of thought (conciseness, grammar, spelling, and written presentation); and
- *Application*: application and understanding of appropriate disciplinary content.

Rubric Scoring

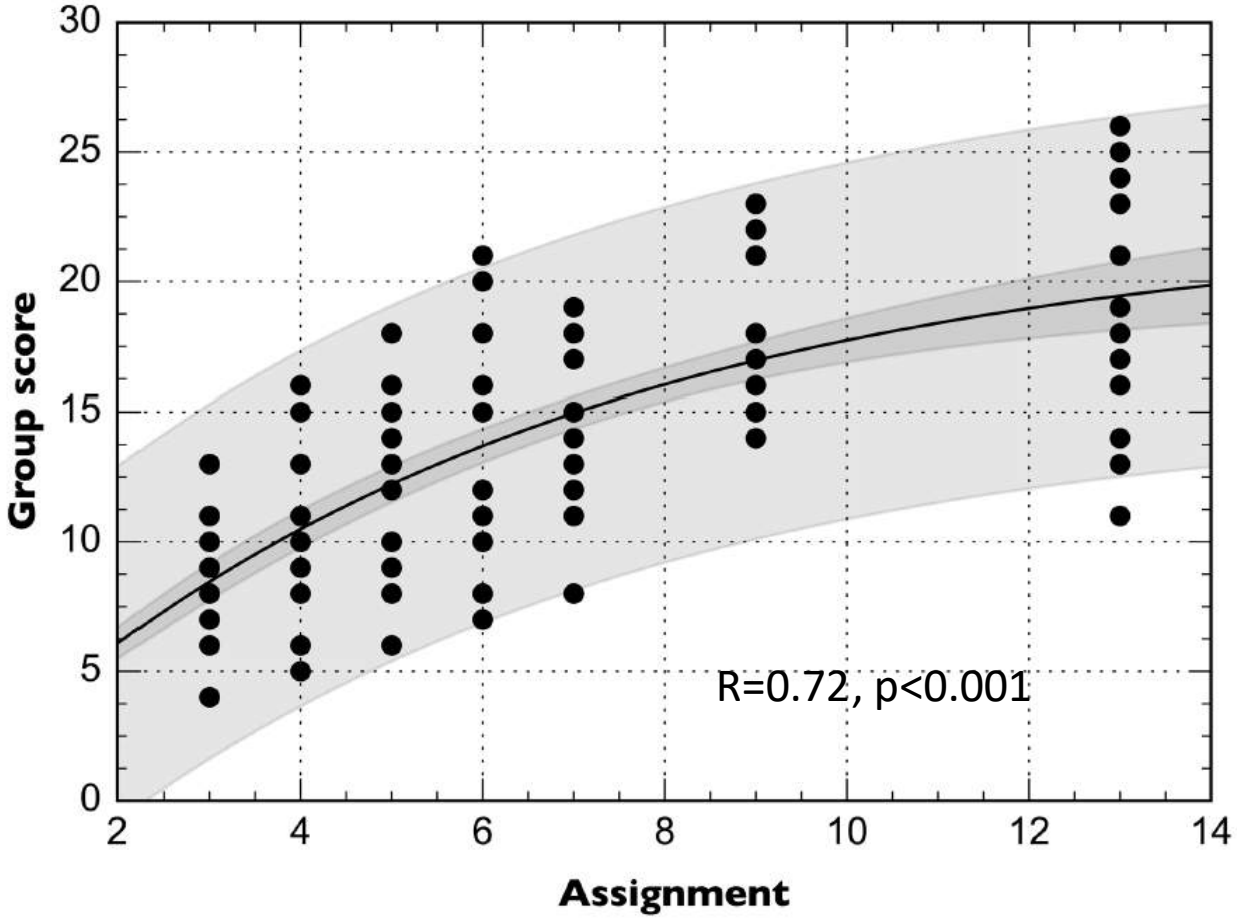
Novice (1)
Advanced Beginner (2)
Competent (3)
Proficient (4)
Expert (5)

IMPROVEMENT IN RUBRIC SCORES OVER YEAR



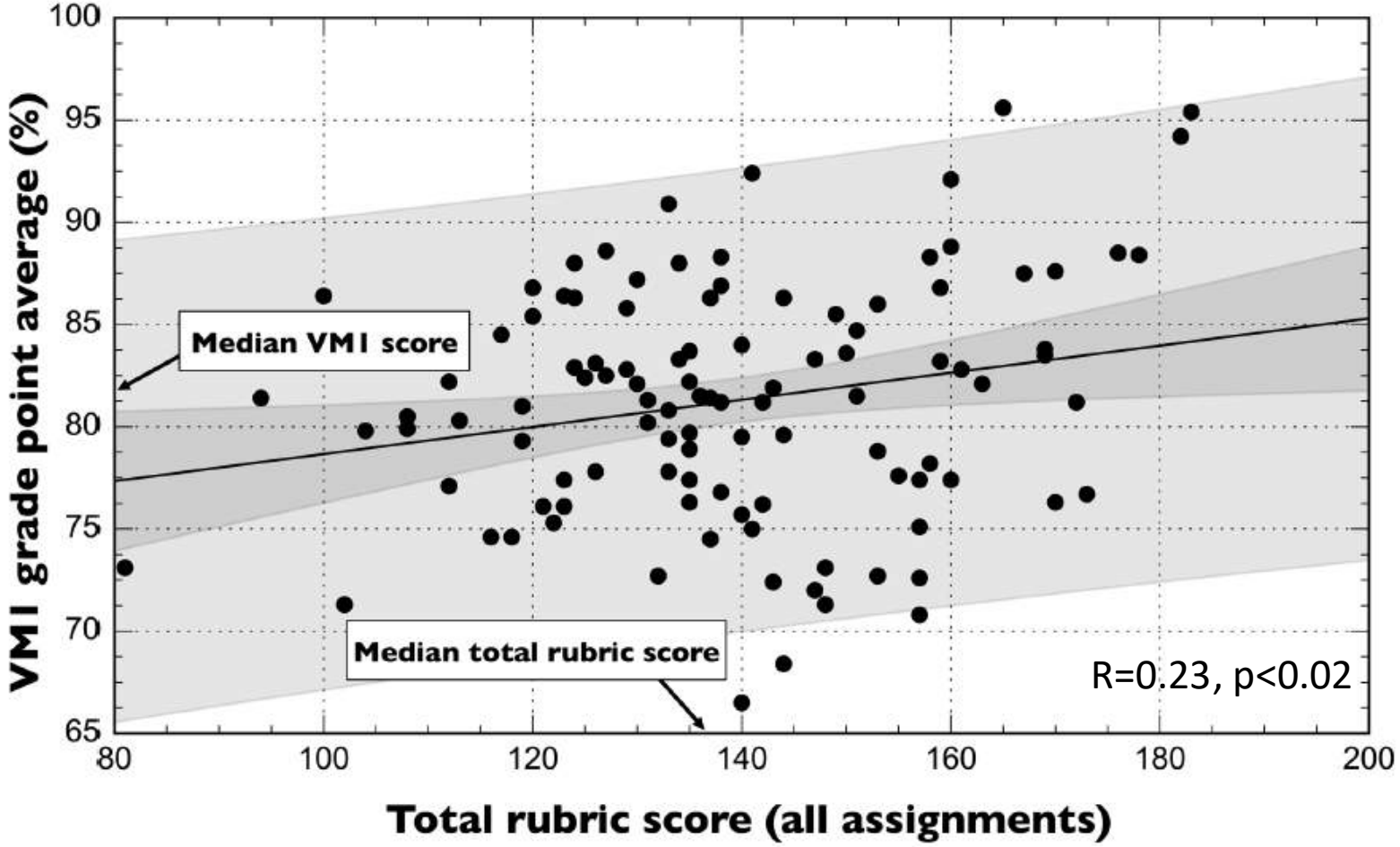
Ferguson DC, McNeil LK, Schaeffer DJ, Mills EM (2017); Encouraging Critical Clinical Thinking (CCT) Skills in First-Year Veterinary Students. *Journal of Veterinary Medical Education* 44(3): 531-541.

CORRELATION OF GROUP TOTAL RUBRIC SCORES WITH ASSIGNMENT NUMBER



Ferguson DC, McNeil LK, Schaeffer DJ, Mills EM (2017); Encouraging Critical Clinical Thinking (CCT) Skills in First-Year Veterinary Students. *Journal of Veterinary Medical Education* 44(3): 531-541.

CORRELATION BETWEEN INDIVIDUAL RUBRIC SCORES AND END-OF-YEAR GRADE AVERAGE



Ferguson DC, McNeil LK, Schaeffer DJ, Mills EM (2017); Encouraging Critical Clinical Thinking (CCT) Skills in First-Year Veterinary Students. *Journal of Veterinary Medical Education* 44(3): 531-541.

SUMMARY AND CONCLUSIONS

1. A year of case analysis exercises had ***no impact*** on individual ***general critical thinking skills*** as measured by a standardized test (CCTTZ).
2. Rubric-based ***instructor evaluation*** of discipline-specific student performance ***improved*** significantly throughout the year.
3. Group ***total rubric scores improved*** even more significantly.
4. Students with ***higher end-of-year GPA performed slightly better on the pre-year CCTTZ.***
5. There was a ***mild but significant correlation between individual rubric scores and the end-of-year grade average.***

Ferguson DC, McNeil LK, Schaeffer DJ, Mills EM (2017); Encouraging Critical Clinical Thinking (CCT) Skills in First-Year Veterinary Students. *Journal of Veterinary Medical Education* 44(3): 531-541.

CBL:
WHY IS IT SO HARD TO IMPLEMENT?

- **Survey:** *For those who have tried it, or based upon what I just described, what do you see as the* ***impediments to implementation****?*

DALL-E 3

FACULTY ISSUES IN DESIGNING CASE-BASED LEARNING

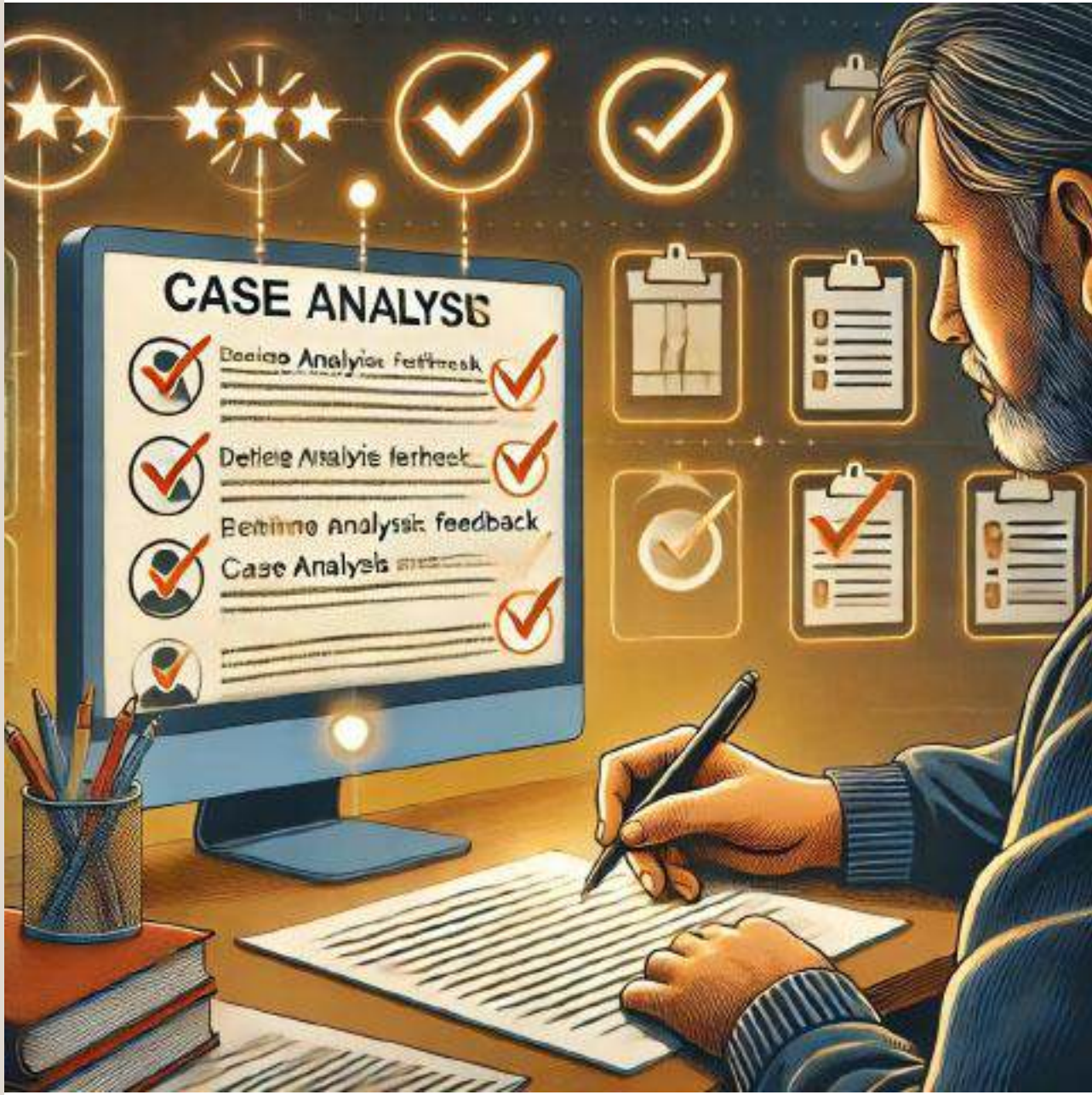
1. **CBL scenarios should be:**
   - Aligned with curriculum
   - Clinically relevant
   - Tailored to student level, challenging enough for growth
2. ***Time-consuming –*** *preparing case and providing feedback*
3. ***Expertise needed?***
   - *Non-DVMs often believe they cannot devise or engage in CBL –* ***FALSE!***

DALL-E 3

ISSUES REVIEWING STUDENT WORK

Useful feedback is:

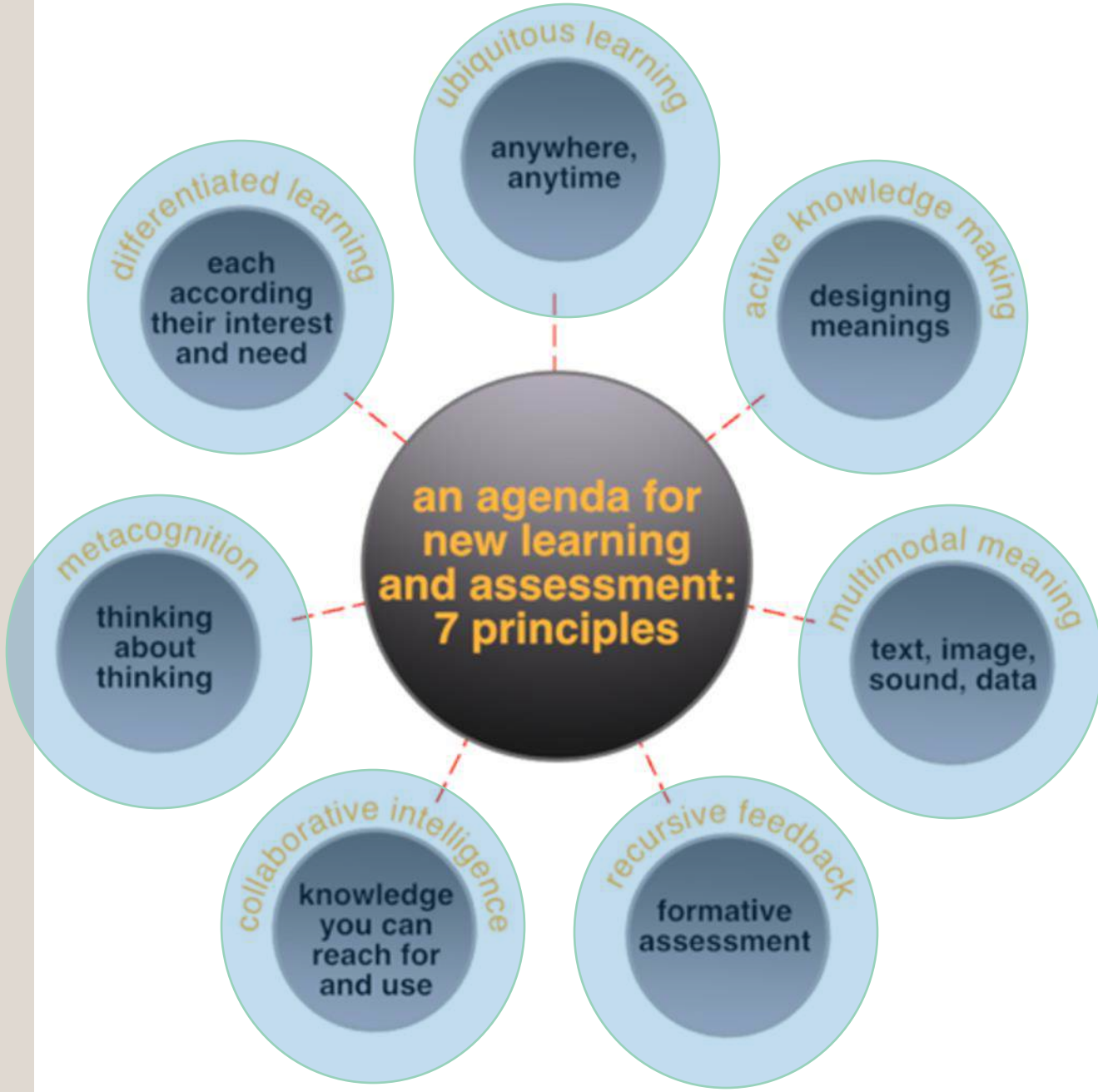
1. **Detailed**
2. **Personalized**
3. **Consistent**
4. **Prompt**
   - Class sizes are large and growing

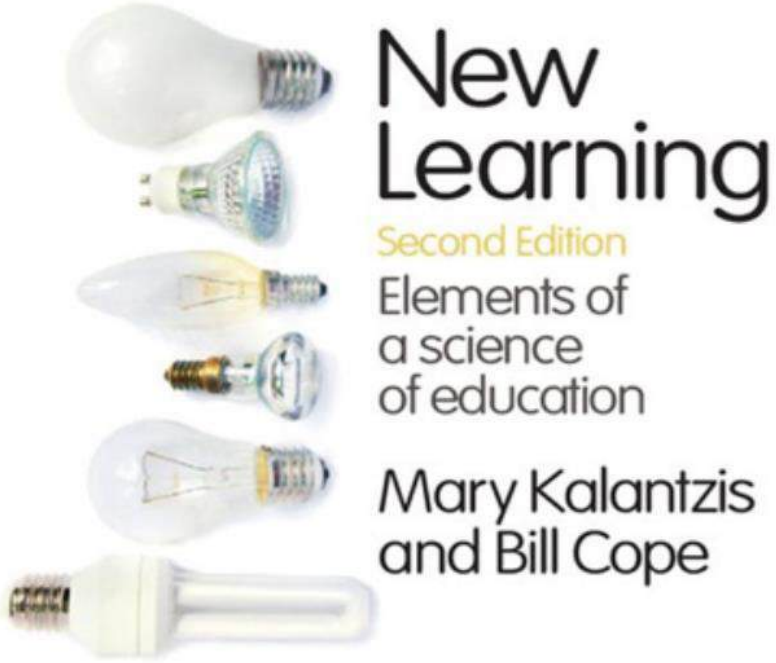


DALL-E 3

7 AFFORDANCES OF TECHNOLOGY FOR LEARNING – KALANTZIS AND COPE

1. Ubiquitous Learning
2. Differentiated Learning
3. Active Knowledge Making
4. Multimodal meaning
5. Metacognition
6. Collaborative Intelligence
7. Recursive Feedback





- ***Knowledge makers***
- Recursive and formative
- Differentiated
- Emphasize self-reflection

"NEW LEARNING" COPE AND KALANTZIS

Characteristics	Didactic	Reflexive
Time and Place	Fixed	Ubiquitous
Learner	Knowledge Consumer	Knowledge Maker
Interactive Modality	Textbooks, Assignments, Tests	Multimodal Knowledge Artifacts
Assessment	Retroactive and Summative	Recursive and Formative
Social	Isolated and Individual	Collaborative Intelligence
Cognition	Remembering Facts/Theories	Metacognition: Self-Reflection
Approach	Standardized, Homogenized	Flexible, Differentiated

CBVE FRAMEWORK FOCUSES ON HIGHER ORDER THINKING

- **Evaluation progress towards a standard of performance**
- American Association of Veterinary Medical Colleges is espousing the development of **competency-based curricular standards:** https://aavmc.org/programs/cbve

DOMAIN 1

Clinical Reasoning and Decision-making

The graduate demonstrates critical thinking and problem solving to arrive at evidence-based decisions that consider animal and client needs, available resources, and social context.

COMPETENCIES		ILLUSTRATIVE SUBCOMPETENCIES
1.1	Gathers and assimilates relevant information about animals	a. Collects history b. Performs physical examination c. Interprets diagnostic test results d. Performs necropsy examination
1.2	Synthesizes and prioritizes problems to arrive at differential diagnoses	a. Identifies problems b. Creates refined problem list c. Prioritizes differential diagnoses
1.3	Creates and adjusts a diagnostic and/or treatment plan based on available evidence	a. Appraises available clinical information and acts accordingly despite uncertainty b. Explains justification for plan c. Re-evaluates animal or population in a timely manner to adjust plan d. Uses critical thinking to determine appropriate action when unexpected outcomes occur (e.g., complications, changed diagnosis)

CBVE: PREPARE FOR LIFELONG AND LIFE-WIDE LEARNING

- Half-life of medical information is down to 70 days
- Day 1 competencies include evidence-based reasoning, argumentation in support of verifiable claims, and testable judgement calls

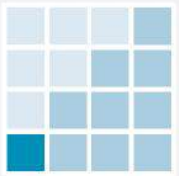
https://aavmc.org/programs/cbve

1.7

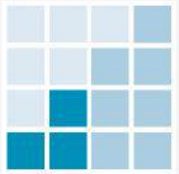
COMPETENCY 1.7

Recognizes limitations of knowledge, skill and resources, and consults as needed

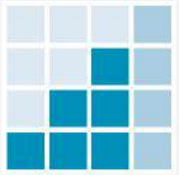
MILESTONES



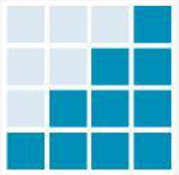
NOVICE:
Overestimates abilities and unaware of limitations. Reluctant to reveal shortcomings or seek advice from others.



ADVANCED BEGINNER:
Recognizes some limitations but overestimates other abilities. Needs help identifying resources for consultation and/or referral.



COMPETENT:
Recognizes own limitations in most situations. Usually seeks guidance when warranted. Occasionally delays timely consultation.

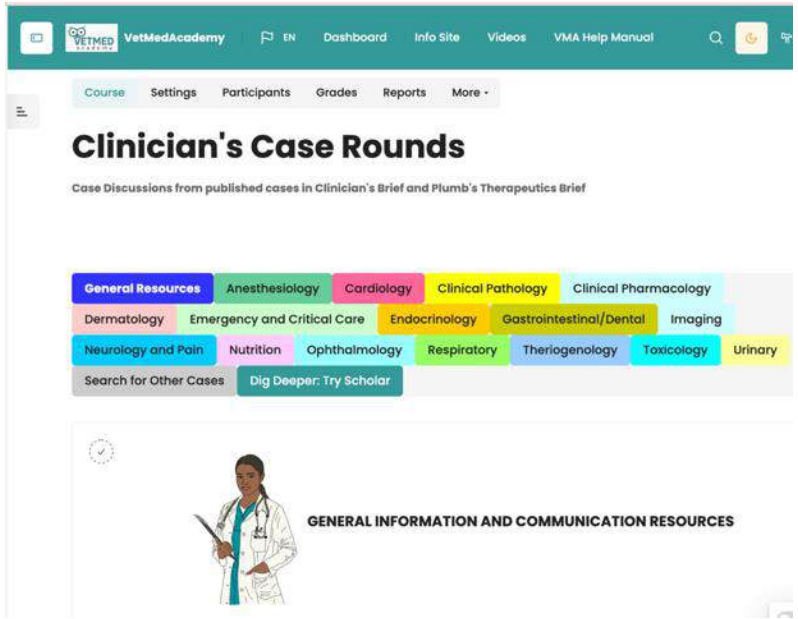


PROFICIENT:
Recognizes own limitations. Anticipates the need for consultation and pursues referral when warranted.

COMMON DIGITAL PLATFORMS IN CASE-BASED LEARNING

- Moodle, Canvas, Blackboard, etc. - generally **replicate standard classroom** functions
- **Monitor student progress** and interactions and can be adaptive
- **Evaluations** (exams, quizzes) most often used to reinforce learning
- **H5P** – tools for interactive video, etc. (https://h5.org and https://h5p.com

https://vmacad.org/course/view.php?id=6



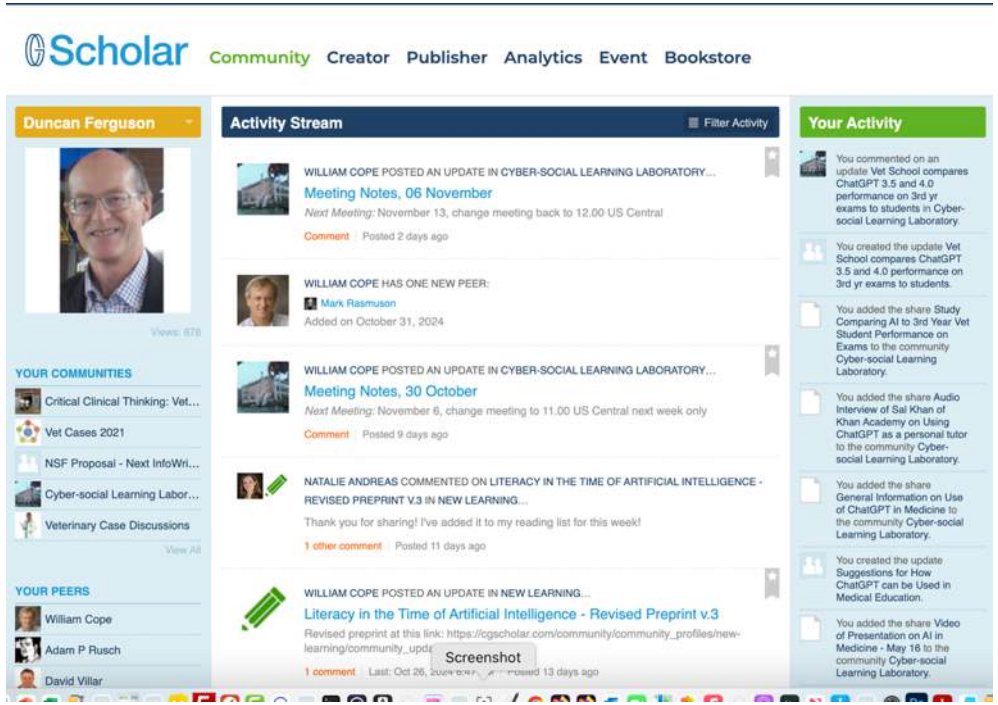
https://vmacad.org/course/view.php?id=29

CGSCHOLAR (CYBERSCHOLAR)

“Social knowledge” communities that document all interactions and allows learner to see progress against instructor goals

Multimedia writing projects focused on formative review:

- **Peer**
- **Self**
- **AI and AI RAG**
- **Faculty – formative or summative**



https://cgnetworks.org/medialab/cgscholar

MULTIMEDIA CASE ANALYSES WITH SCHOLAR

1. **Instructor Demonstration Case – *"See One"***
2. **Case Analyzed by Entire Class: *"Do One":* Peer Reviewer Also Analyzes Case**
3. **¼ of class analyzes a particular case and peer reviews 3 others. *"Review 3"***

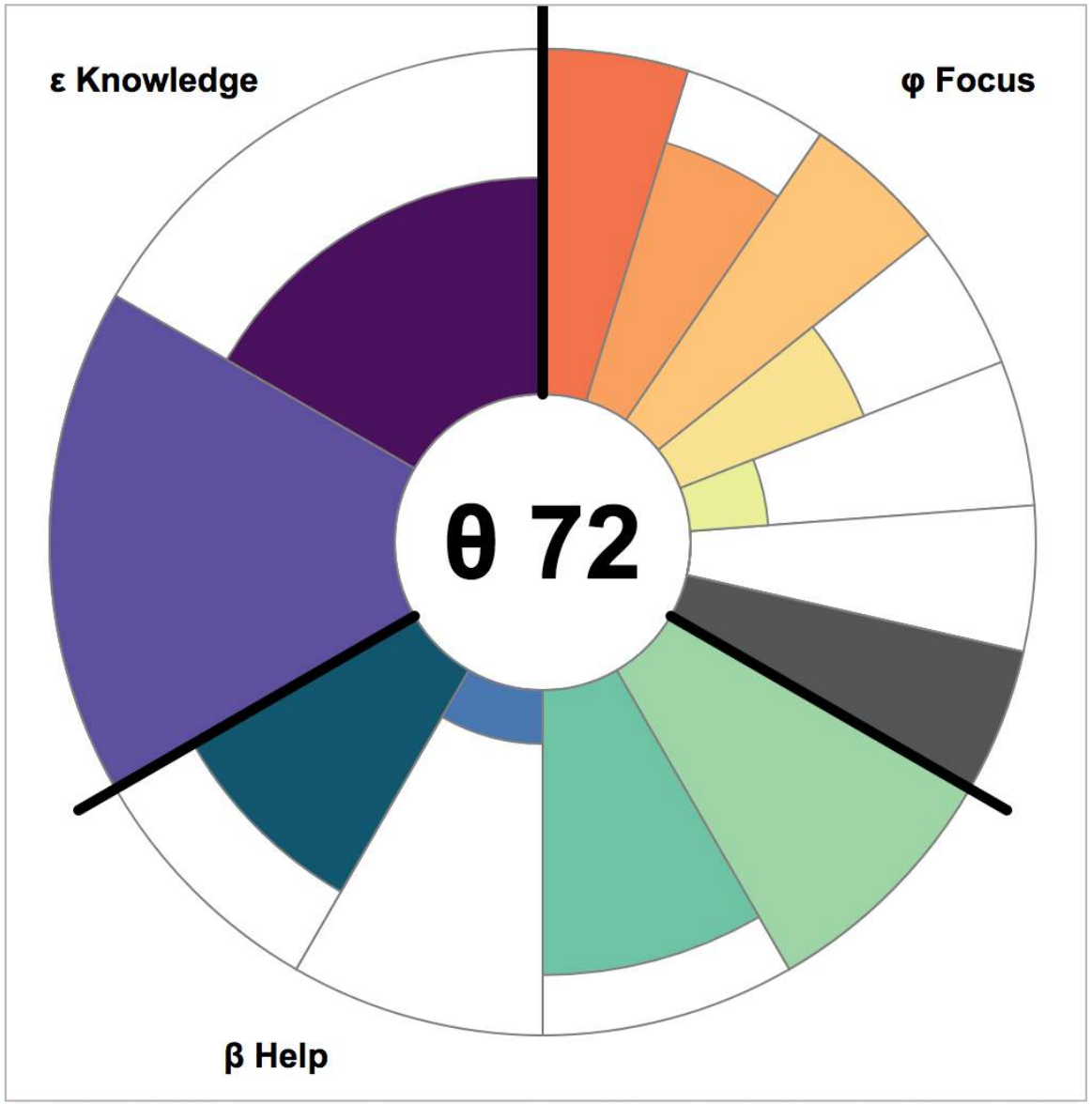
Course & Semester	Case # : Title	Medical Condition	Special Notes
2015 - 1st	0: Stunted Puppies	Congenital Hypothyroidism	Demonstration by Instructor
	1: Rottie	Diabetes Mellitus	1 of 4 cases assigned to 1/4 of class
	2: Cow 202	Cow with Periparturient Hypocalcemia	
	3: Pom Pom and Foo Foo	Pups with Pituitary Dwarfism	
	4: Jazzy	Dog with Addison's Disease	
2016 - 2nd	5: Charlie, the Coughing Dog	Bronchiectasis	Analyzed by all students
	6: Nala the Coughing Dog	Mitral valve prolapse and Congestive Heart Failure	1 of 4 cases assigned to 1/4 of class
	7: Maggie, the Vomiting Dog	Pancreatitis	
	8: Miss Tiggles, Cat with Inappropriate Urination	Cat with Inappropriate Urination	
	9: Bovine Herd Health Case	Traumatic Reticulitis and Sepsis	
2016 - 2nd	10: Buggy	Primary hyperparathyroidism	
	11: Saddle Up	Reproductive Failure in Mare	
	12: Schatzie	Polydipsia	
2017 & 2018 - 2nd	13: Lemur Case	Tetralogy of Fallot	All students assigned case
	14: Paint Filly	Red Maple Leaf Toxicosis in a Horse	1 of 4 cases assigned to 1/4 of class
	15: Natalie	Stasis of Rumen and Intestine in a Cow	
	16: Hank	Pulmonic Stenosis in a Dog	
	17: Randall	Megacolon in a Cat	

UPDATED RUBRIC AND PEER SCORING

- **Problems:** the student should list the three most serious clinical problems in this case,and defend his/her reasoning.
- **Differentials:** the student should identify at least two major differential diagnoses for the animal and defend his/her choices with evidence from the case and information from the literature.
- **Evidence:** The student should identify the clinical observations in this case to support his problem list and differential diagnosis list.
- **Understanding:** The student should respond to various questions in order to evaluate his understanding of the case. For example: “If unmanaged, what kind of additional clinical signs would you expect?"
- **Conclusions:** The student should identify and explain at least 2 personal learning issues from the exercise.
- **References:** The student should provide references that helped him with understanding of this case.
- **Overall:** The overall impression of the reviewer from the analysis.

- **Peers scored from 1-4 for strongly disagree, disagree, agree, strongly agree**

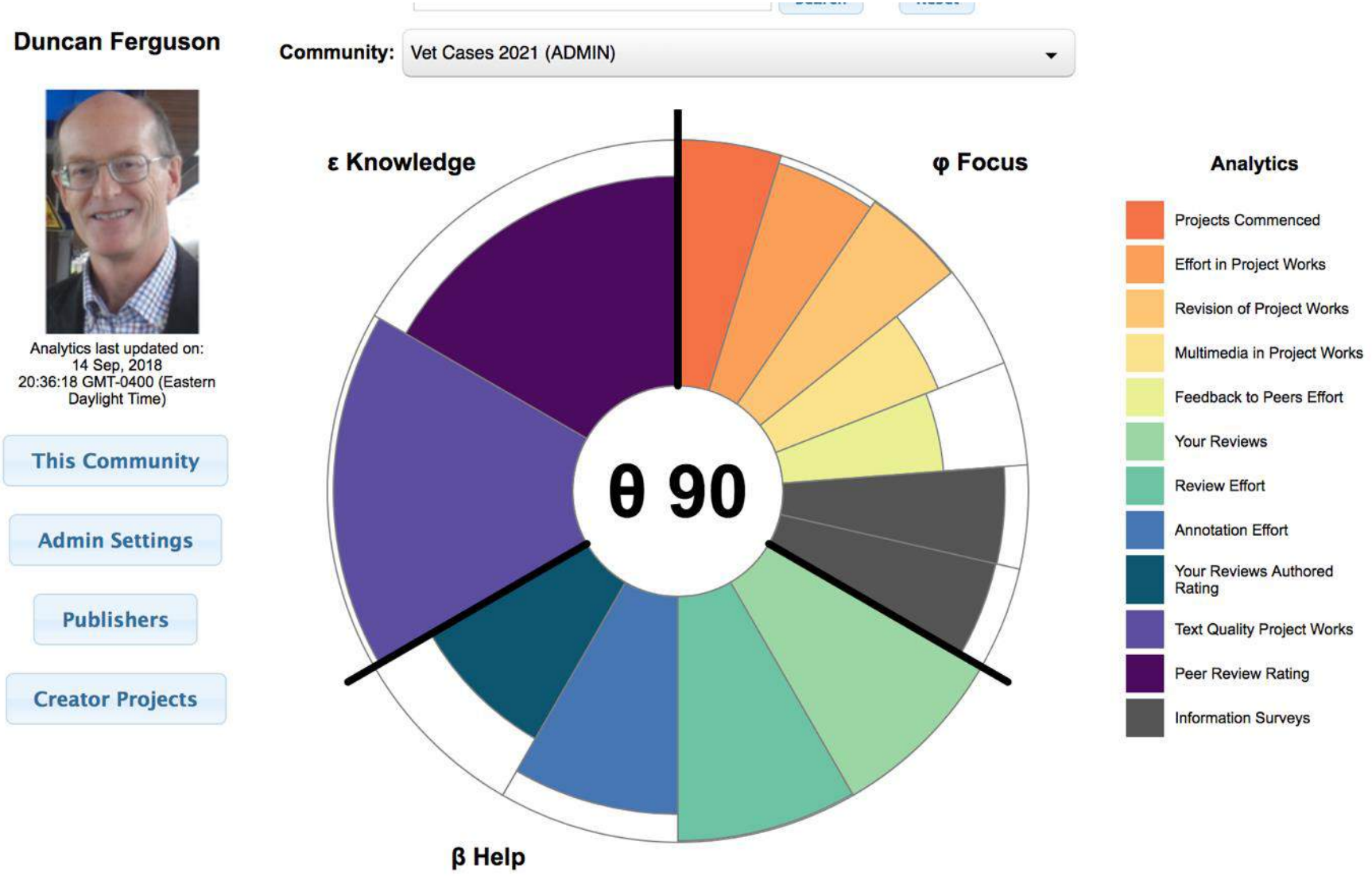
LEARNER ASTER PLOT



Analytics

- Projects Commenced
- Effort in Project Works
- Revision of Project Works
- Multimedia in Project Works
- Feedback to Peers Effort
- Your Reviews
- Review Effort
- Annotation Effort
- Your Reviews Authored Rating
- Text Quality Project Works
- Peer Review Rating
- Information Surveys

COMPOSITE CLASS ASTERPLOT



This visualization of learning metrics is based on **10,500** metric values derived from **1,654,640** total data points collected across all members of this community.

RETROSPECTIVE STUDY OF STUDENT OPINION ABOUT CGSCHOLAR: CLASSES OF 2019-2021 AT ILLINOIS

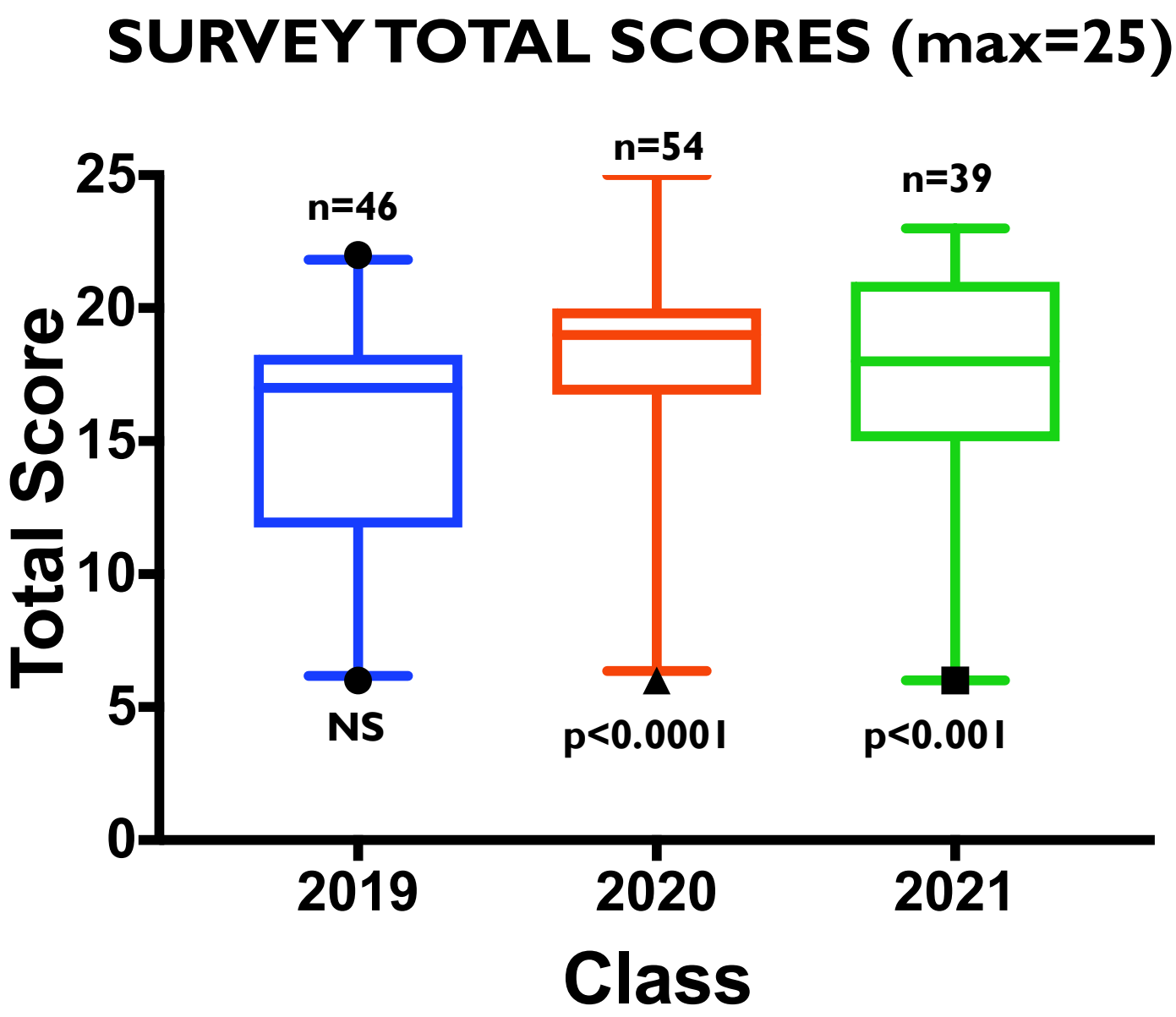
Hypothesis: Iterative improvement in platform format for timely student feedback led to a more positive experience during case analysis exercises

McMichael MA, Ferguson DC, Allender MC, Cope W, Kalantzis M, Haniya S, Searsmith MCS (2021). Use of a multimodal, peer-to-peer learning management system for introduction of critical clinical thinking to first year veterinary students. J. Vet. Med. Ed. 48(2):170-180. https://doi.org/10.3138/jvme.2019-0029

SURVEY QUESTIONS

- **Q2:** Inclusion of ***multi-media*** in my work enhanced my ability to communicate my thoughts about the assigned case exercise
- **Q3:** When I performed ***peer review*** on a classmate's case analysis, the use of ***multi-media*** enhanced my ability to understand my peers' answers
- **Q4:** The case exercises gave me a better understanding of what constitutes high quality ***literature evidence***
- **Q5:** ***Peer review*** of a classmate's work was helpful in identifying weaknesses in my own analysis
- **Q6: Peer review of my work** was important in the improvements I made between the first and final drafts of my analysis
- **Scale:** Highly Disagree (1), Disagree (2), (Neutral (3), Agree (4), Highly Agree (5)

Relative to Neutral
ANOVA (non-parametric)
p=0.002
Kruskal-Wallis test



CONCLUSIONS

- Students in ***Years 2 and 3 were generally positive*** about the experience; Students in ***Year 1 were neutral***
- ***Multi-media enhanced the experience*** for students in Years 2 and 3
- Students in ***Year 2 saw connection with understanding quality of evidence***; other years may have tired of the message
- Most students in ***Years 2 and 3 felt that they had positive benefits from the peer review process***

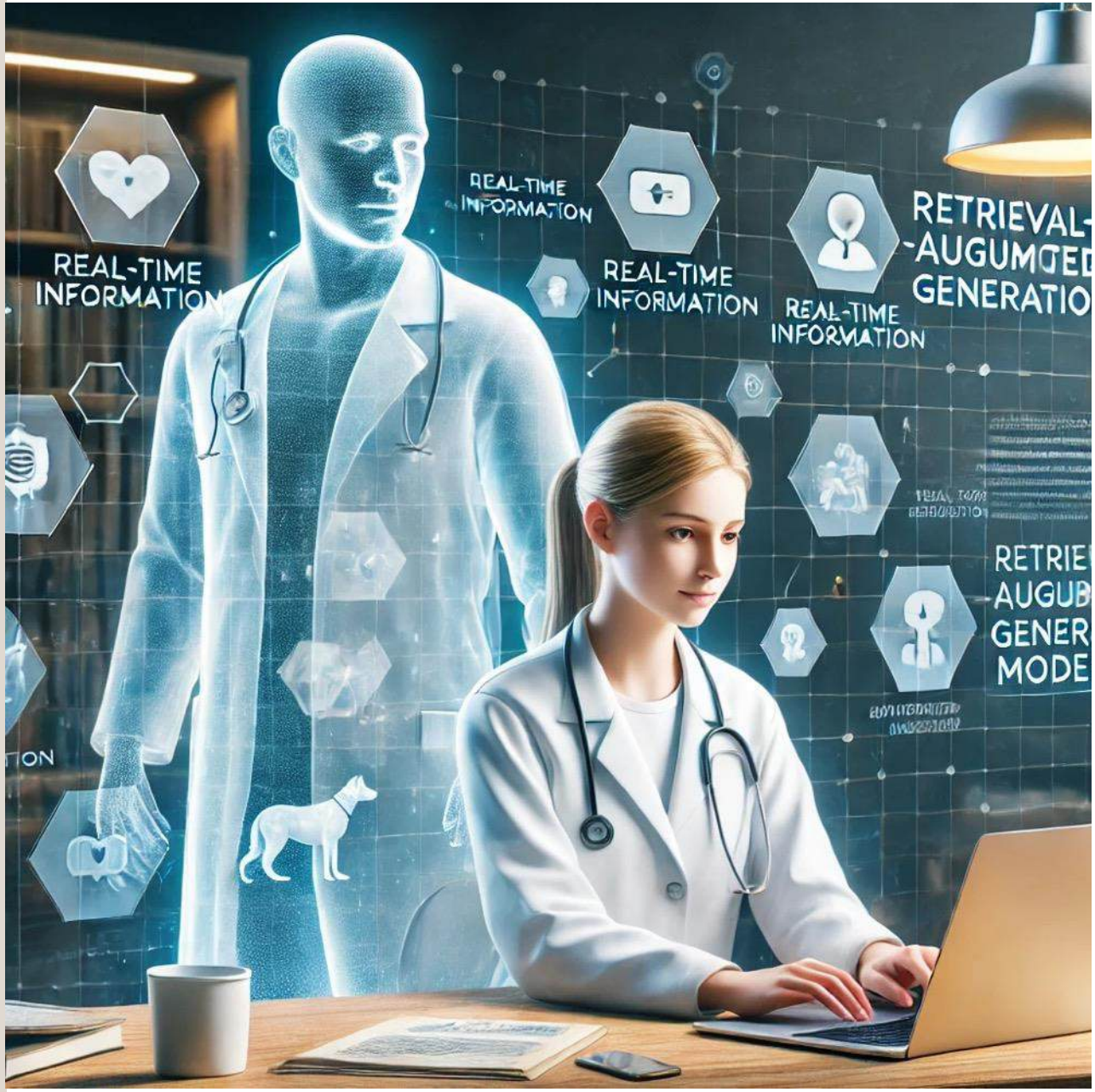
NEAR FUTURE

LEVERAGING AI AND RAG MODELS

- **Retrieval-Augmented Generation (RAG)** combines language generation (LLM) with a knowledge database

- **Realtime accurate guidance** of students as they practice medical reasoning

- Crucial ***extension of the instructor*** via rubric-driven goals and principles



DALL-E 3

USING RAG WITH RELIABLE MEDICAL SOURCES

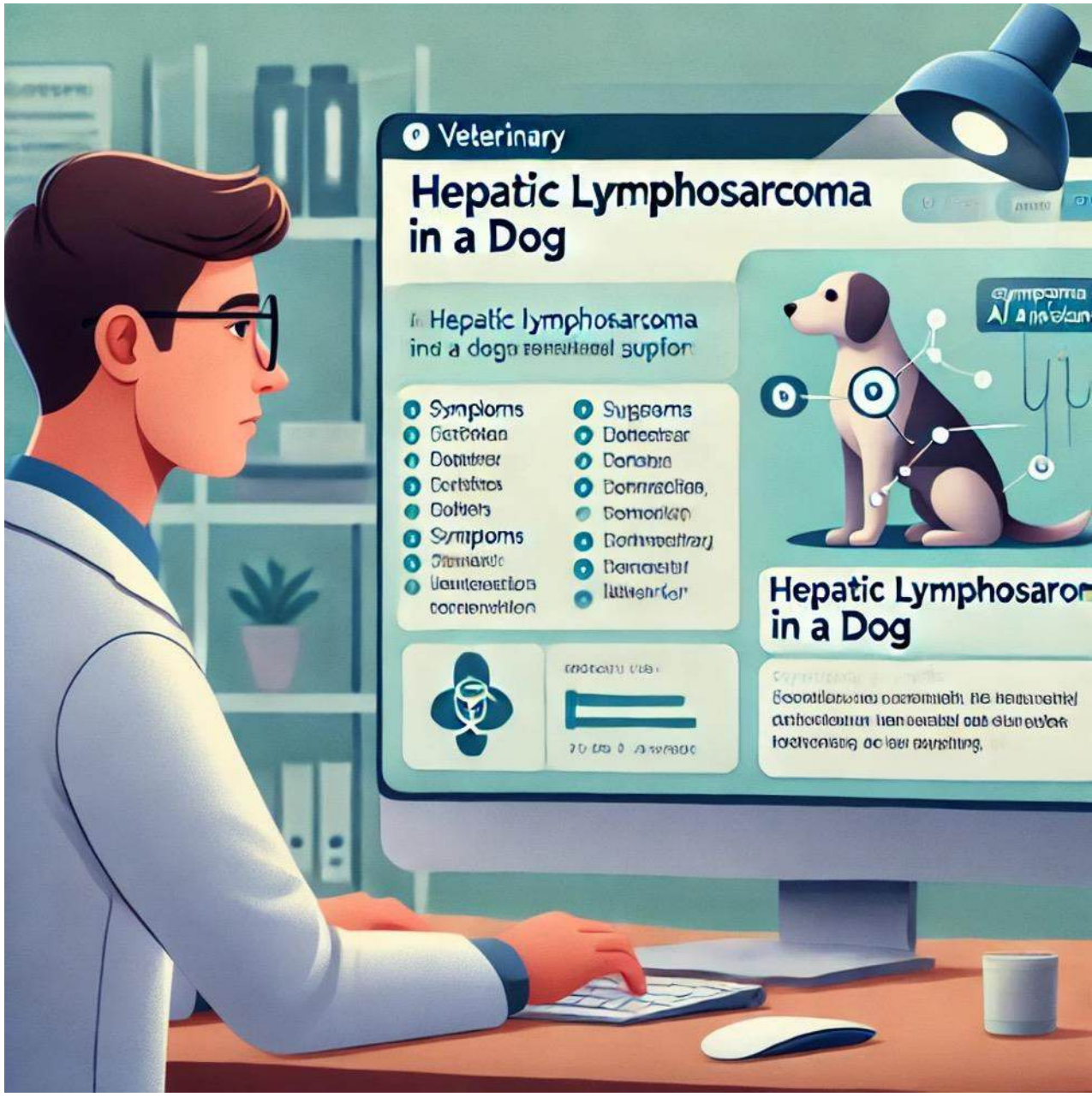
- ***Diminishes "hallucination"*** around crucial medical facts
- Real-time access to ***peer-reviewed*** medical source(s) – e.g. ***Merck Veterinary Manual***

Modified DALL-E 3

EXAMPLE: USING AI IN A VETERINARY CASE

Example Scenario: Case of Hepatic Lymphoma in the Dog

- Students prepare **S/O/A/P** from case record
- Analysis created by RAG-LLM ChatGPT interaction using Retool app



DALL-E 3

STEPS INCLUDING RAG LLM IN AI REVIEW PROCESS

1. **Medical Text** (e.g. student case analysis) entered or drawn from “work” in CyberScholar
2. **Rubric** entered or drawn from instructor-created rubric
3. **Knowledgebase** (e.g. Merck Veterinary Manual) queried with vector search for relevant ”chunks” of data to inform model
4. **Prompt** created from a prompt prefix (general directions), rubric, Knowledgebase excerpts and case text.
5. **ChatGPT interaction** to create the AI Review
6. **Top articles referenced** provided as URL links.

RAG LLM AI REVIEW

1 Intro — 2 Enter Medical Text — 3 Enter Review Criteria — 4 Build Custom Knowl... — 5 Prompt Build — 6 GPT Interaction — 7 Suggest Readmgs

Load Data from Other Components

Now we will assemble the prompt. Firstly, modify the Prompt Prefix according to your case. It is separate but more general instructions than the rubric. Then press 'Load Data from Other Components' to populate the fields in this view from previous steps -- these will be building blocks of the final prompt. Be sure to Zoom Out to see the Build Prompt and Next buttons. Press 'Build Prompt' to assemble and display the final ptrompt to be sent to the LLM. When finished, press 'Next →'

Prompt Prefix (general instructions)

Enter Prompt Prefix

Clear Prompt Prefix

Document Structure: The document you should consider for the following described review has the following structure with 2 sections and 4 subsections:
1. "Case Information" starting with the phrase "CASE START" and ending with "CASE END".
2. "SOAP Notes" starting with the phrase "SOAP START" and ending with "SOAP END".
3. Subsections of the "SOAP Notes" include:
a. "Subjective" starting with the phrase "SUBJECTIVE:" and ending before the phrase "OBJECTIVE:"
b. "Objective" starting with the phrase "OBJECTIVE:" and ending before the phrase "ASSESSMENT:"
c. "Assessment" starting with the phrase "ASSESSMENT:" and ending before the phrase "PLAN:"
d. "Plan" starting with the phrase "PLAN:" and ending before "SOAP END".
Directions for Conducting Review: Using the guidelines in the Criterion Text, review only the "SOAP Notes" subsection with the title that is stated at the beginning of the Criterion Text. The included "Case Information" section includes the currently available case information. However, do not write a review of it, nor of the 3 subsections of the "SOAP Notes" not stated at the beginning of the Criterion Text. Appropriate parts of the "Case Information" may chosen by the author to include in the section of the "SOAP Notes", but the author must repeat or summarize the relevant information in the subsection of the "SOAP Notes" in order for you to credit the author for including it, and the information provided by the author must meet the Criterion Text guidelines. Reference the Knowledgebase Text Contribution as additional information to compare to the author's assertions. In addition to creating the review text, provide an integer rating on the scale of 0 to 4 in the format 'Rating: ' using descriptions of the rating levels in the Criterion Text.

Criterion (Rubric) Text

PLAN subsection review instructions: Please review only the 'Plan' subsection under 'SOAP Notes' for the following document. Do not include or consider any other sections or subsections such as 'Case Information,' 'Objective,' 'Assessment,' or 'Subjective.'
Considering only the 'Plan' subsection, write a review as to whether the author describes and categorizes the following types of information in this this subsection:
a. The author develops a diagnostic and treatment plan for each differential diagnosis.
b. The author's diagnostic plan may include tests, procedures, other laboratory studies, consultations, etc.
c. The author's treatment plan should include: client/owner education, pharmacotherapy if any, plans for monitoring of therapy, other therapeutic procedures. Immediate and long-term treatment plans should be addressed as well as plans for follow-up (next scheduled visit, etc.).

Knowledgebase Text Contribution

Knowledgebase Article Excerpt:
Diagnosis is usually based on a thorough history, clinical findings, and response to symptomatic treatment. A specific diagnosis should be sought if the animal has had access to foreign objects or toxins, if clinical signs do not resolve within 2 days of symptomatic therapy, if hematemesis or melena are present, if the animal is systemically unwell, or if abnormalities are noted on abdominal palpation. Dogs may signal the presence of cranial abdominal

Build Prompt

← Previous

Next →

Built Prompt (if visible, press "Next")

Document Structure: The document you should consider for the following described review has the following structure with 2 sections and 4 subsections:
1. "Case Information" starting with the phrase "CASE START" and ending with "CASE END".
2. "SOAP Notes" starting with the phrase "SOAP START" and ending with "SOAP END".
3. Subsections of the "SOAP Notes" include:

clinical signs consistent with liver failure. These can often be bridged with supportive care to achieve hepatic regeneration.

RUBRICS (PROMPTS) TO SUPPORT AI-DRIVEN FEEDBACK

- Provide a clear ***framework*** for assessment by peers or AI tool
- ***Guide*** students in their case analysis approach
- ***Standardize*** formative feedback: AI ***rigorously follows rubric criteria***, and is evidence-based, providing the ***reference source***

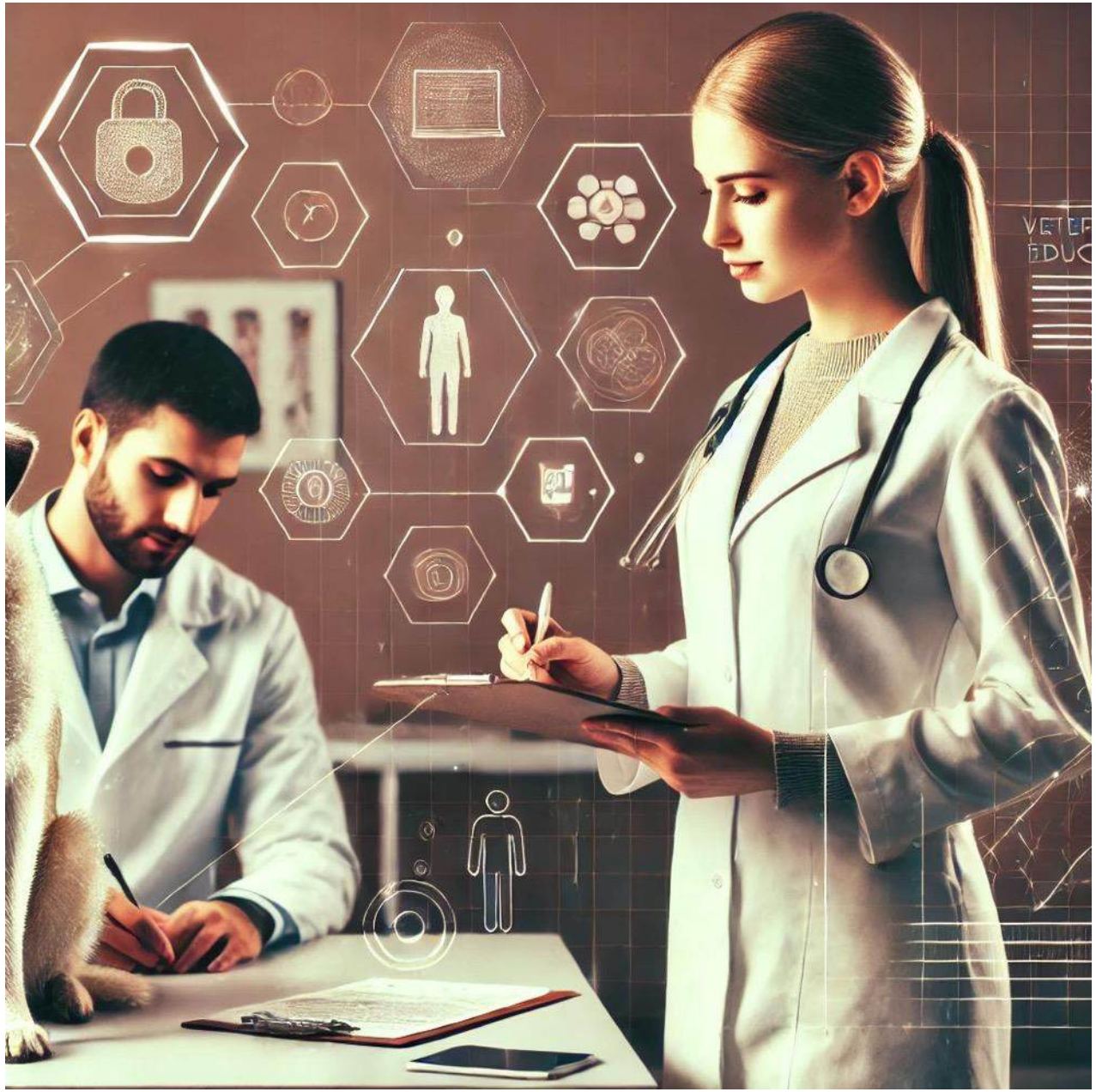
DALL-E 3

CONCLUSIONS AND FUTURE DIRECTIONS

1. CBL enhances ***student engagement and learning outcomes***, including self-reflection.

2. **AI** has the potential to ***reduce faculty workload*** in grading and feedback

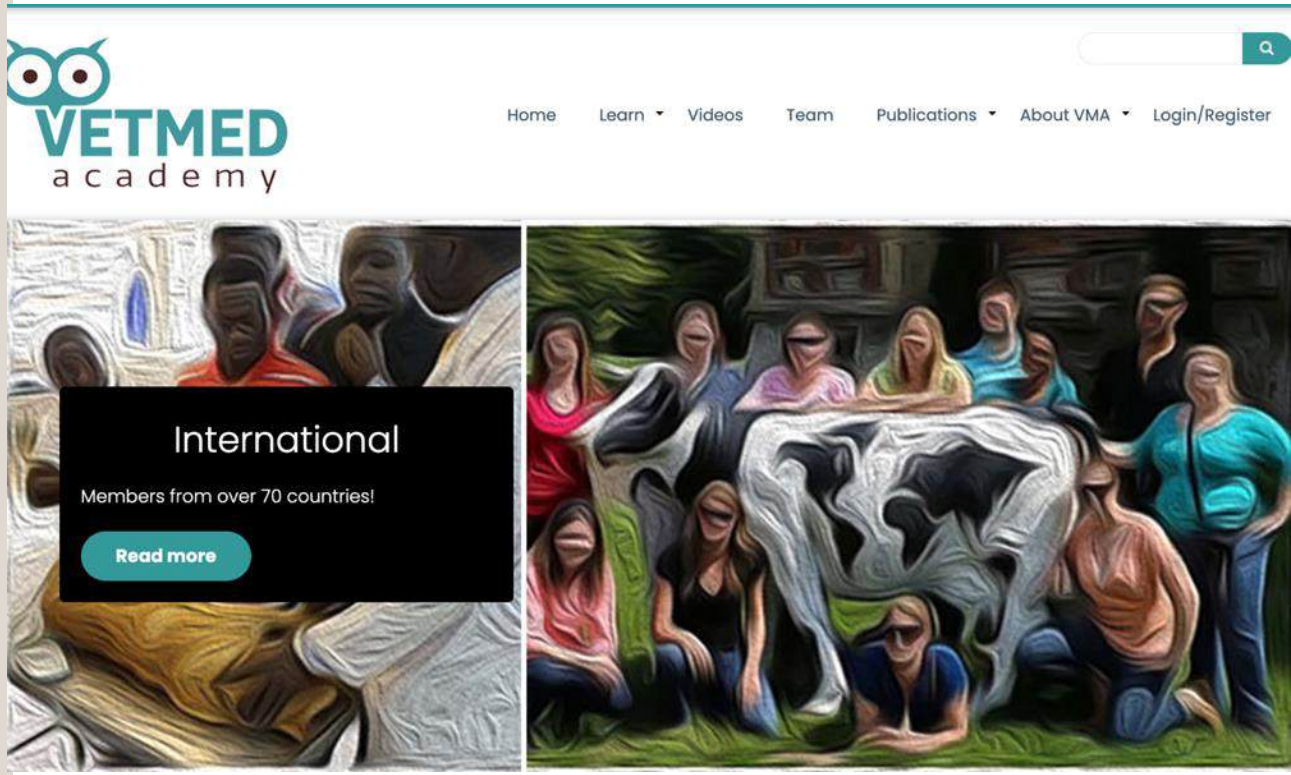
3. ***Continuous improvements in AI*** technology will enhance this ”extension” of an instructor and ***allow more complex case scenarios and assessments***.



DALL-E 3

OPEN EDUCATIONAL RESOURCE-SHARING: VETMEDACADEMY

- ***Free*** to students, faculty, and others in the veterinary profession
- **International**: 70 countries
- **Self-study or review**
- **Modular content** is portable and adaptable for interested instructors
- **Open Educational Resources** encouraged: *Creative Commons Attribution* model
- **Content partners:** *Merck Veterinary Manual Vet-Library.com, and Clinician's Brief*



Info Site: https://vetmedacademy.org
Moodle LMS (register):
https://vmacad.org

THANK YOU

ANY QUESTIONS?

Simulated oil painting of actual photograph of students working on a clinical case