For accreditation AVMA COE requires outcome assessment of competencies

From 12.11.1.c.

1. The college must develop relevant measures and provide evidence that graduating students have attained the following competencies:” (9 listed)
2. “Provide the learning objectives for each, and a summary of the analysis of evidence-based data collected for each to assure that graduates are prepared for entry level practice . . .
3. “Evidence of student learning outcomes for clinical competencies must be obtained by direct measures. These may include capstone experiences, student portfolios, standardized clinical proficiency exams, or other evaluations of clinical performance based on measurable and published program objectives”
4. “Indirect measures should not be used as the sole determinants of clinical competency outcomes. Examples include employer surveys and student course or rotation grades”

The mission statement in an early draft of a Curriculum Committee by-laws update

The mission of the CVM Professional Curriculum Committee is to design, organize, maintain, and oversee the professional DVM curriculum so that the DVM Curriculum:
1. Is efficient, effective, fair, and balanced
2. Reflects advancing evidence-based pedagogy and technology adopted in a timely fashion
3. Is attractive to the stronger candidates for admission
4. Exceeds the AVMA COE requirements for accreditation

Several papers list skills in which employers expect new graduates to be competent

Some examples:

1. Hill et al (2012), Frequency of use and proficiency in performance of surgical skills expected of entry-level veterinarians by general practitioners
   - JAVMA 240(11):1355-1358
2. Hubbell et al (2008), Frequency of activities and procedures performed in private equine practice and proficiency expected of new veterinary school graduates
   - JAVMA 232(1):42-46
3. Greenfield et al (2004), Frequency of use of various procedures, skills, and areas of knowledge among veterinarians in private small animal exclusive or predominant practice and proficiency expected of new veterinary school graduates
   - JAVMA 234(21):1780-7
   - JAVMA 224(6):347-353
5. Morin et al (2002), Surgery, anesthesia, and restraint skills expected of entry-level veterinarians in bovine practice
   - JAVMA 220(7):939-974

Although human learning is very resilient, if we know how it works better can we do better?

Many of “the greatest generation” were educated in one room prairie schoolhouses

No running water
No electricity
Teacher one summer school
past high school

Learning results from what the student does and thinks, and only from what the student does and thinks

The teacher can advance learning only by influencing what the student does to learn

Herbert A. Simon (1916 – 2001)
Similar comments appear repeatedly across these papers

- Hill – “...common comments... included requests for schools to improve efficiency and abilities of new graduates to perform common surgical procedures, such as ovariohysterectomy, castration, declawing, cystotomy, mass removal, laceration repair, and basic wound management”
- Morin – “The most frequent comment was that students need more hands-on training in technical procedural skills. ... practitioners expected entry-level veterinarians to have good skills and require little supervision in a number of surgery, anesthesia, and restraint procedures. ... Practitioners identified surgical and restraint skills among the most important yet most deficient skills”
- Hubbell – “…respondents expected that entry-level veterinarians would be able to perform 51 of the 151 tasks unsupervised or with minimal supervision…”
- Root Kustritz – “…employers rated overall proficiency of new veterinary graduates as adequate for 3 of 9 procedures in horses, 5 of 9 procedures in cattle, and 8 of 9 procedures in small animals…”

Basically - Improve new graduate competence!

One taxonomy classifies skill components into three domains – cognitive, perceptual, and motor

Definitions:
- **Skill**: A learned, goal-directed activity entailing a broad range of behaviors
- **Cognitive component**: Component for which success is determined by knowledge and cognitive capabilities
  - Knowing what to do
- **Perceptual component**: Component for which success is determined by ability to discern and to discriminate between sensory stimuli
  - Getting the information to do it
- **Motor component**: Component for which success is determined by quality of movement
  - Doing it and doing it correctly
- **Other skill taxonomies**: Psychomotor – movement associated with conscious mental activity

VM 568 Animal Handling starts the progression of technical “hands-on” medicine

<table>
<thead>
<tr>
<th>DVM</th>
<th>4th Year Clinic Rotations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Advanced Procedures</td>
<td></td>
</tr>
<tr>
<td>Basic Clinical Procedures</td>
<td></td>
</tr>
<tr>
<td>Basic Physical Exam – Visual, TPR</td>
<td></td>
</tr>
<tr>
<td>Initial Restraint – Tying, Stocks</td>
<td></td>
</tr>
<tr>
<td>Initial Control – Haltering, Leashing</td>
<td></td>
</tr>
<tr>
<td>Approach &amp; Contact – Kennel, Stall, Pen</td>
<td></td>
</tr>
</tbody>
</table>

First Year

VM 568 - Understand what critters are telling you

Useful functional competence definitions are scarce

<table>
<thead>
<tr>
<th>Skill</th>
<th>Proficiency Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>IV Catheterization - Peripheral</td>
<td>Place appropriately-sized IV catheter that remains patent for at 2 - 3 days</td>
</tr>
<tr>
<td>Venipuncture</td>
<td>Collect on 1st or 2nd try &gt;75% of the time from cephalic, saphenous, or jugular with minimal restraint in an average patient</td>
</tr>
<tr>
<td>Dental Extraction - Multifoliate</td>
<td>Take less than 1 hr using a textbook technique with a positive outcome &gt; 90% of the time</td>
</tr>
<tr>
<td>Castration Canine</td>
<td>Take less than 30 min using a textbook protocol with a positive outcome &gt; 95% of the time</td>
</tr>
<tr>
<td>Ovariohysterectomy - Canine less than 50 pounds</td>
<td>Take less than 45 minutes to remove the ovaries and uterus using a textbook protocol with a positive outcome &gt; 95% of the time</td>
</tr>
<tr>
<td>Wound Management</td>
<td>Evaluate wound severity, determine appropriate treatment (i.e. surgical repair, wet-to-dry bandages, second intention healing, etc.) and treat with positive outcome &gt; 75% of the time</td>
</tr>
</tbody>
</table>

http://www.vetmed.wsu.edu/courses-jmgay/documents/BASkillInventory.pdf
VM 568 - Learn a systematic approach to visual appraisal

Remember:
More is missed from not looking than from not knowing!

See anything here?

VM 568 - Learn normal and abnormal appearances

Sick!
Normal

VM 568 - Learn normal and abnormal postures and gaits

Abnormal
Normal

Why? Her hind feet hurt

VM 568 - Why do you need to know how to use rope restraint?

Constantly using ropes!

VM 568 - Prepare for clients with no restraint facilities

"Doc, we called you because he’s lame"

Note the size of those horns
Do you see any restraint facilities anywhere?

VM 568 - Learn to tie restraint knots quickly and correctly!

• Know how to tie each
  – Know how to keep from losing fingers or limbs!
• Know why and when to use each
  – Non-slip but quick release
  – Prevent choke
  – Prevent Wrecks

Practice, Practice, Practice
Motor components take longer to teach and are more difficult to retain than cognitive components

Hubbel – evidence from human medicine
- 50% - 60% of physical skill proficiency lost in 2 yrs, associated knowledge diminished only 10%
- Medical students required 15 repetitions to reach baseline endotracheal intubation competency and without practice their skills declined significantly in 4 months
- More complex procedures have flatter learning curves, epidural anesthesia requiring 90 attempts for residents to achieve a 80% success rate
- “For veterinary procedures the number of instruction episodes required to attain a given success rate has not been identified, but a single exposure is likely insufficient”

What are the pedagogical “best practices” for accomplishing learning outcomes?

There are known knowns
These are things we know that we know
There are known unknowns
That is to say, there are things that we know we don’t know
But there are also unknown unknowns
There are things we don’t know we don’t know

Donald Rumsfeld

Due to research technology breakthroughs, human learning is an increasingly active research area

Number of PubMed search term hits by decade:

<table>
<thead>
<tr>
<th>Publication year</th>
<th>brain fMRI</th>
<th>brain learning</th>
<th>fMRI brain learning</th>
<th>neuroplastic</th>
</tr>
</thead>
<tbody>
<tr>
<td>1991</td>
<td>1,640</td>
<td>1,200</td>
<td>27</td>
<td>10</td>
</tr>
<tr>
<td>2001</td>
<td>4,851</td>
<td>2,881</td>
<td>347</td>
<td>73</td>
</tr>
<tr>
<td>2011</td>
<td>10,283</td>
<td>6,414</td>
<td>1,347</td>
<td>361</td>
</tr>
</tbody>
</table>

As with any science area, some findings are surprisingly counterintuitive
Effect of 70 RPM pedaling to exhaustion done before practice or after practice on motor skill retention pattern compared to controls

Roig et al. A single bout of exercise improves motor memory

Fitts and Posner proposed 3 motor learning stages: cognitive verbal, associative, and autonomous

Statistically significant differences between all groups at 7 days

<table>
<thead>
<tr>
<th>Performance</th>
<th>Accumulating Learning Events</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fast Cognitive Stage</td>
<td>Intermediate Autonomous Stage</td>
</tr>
<tr>
<td>Plateau</td>
<td></td>
</tr>
</tbody>
</table>
For the expert, the Fitts and Posner model needs another stage - complacency

Complacency motivates the recent development of medical checklists but evidence is mixed

Ko et al. Systematic review of safety checklists for use by medical care teams in acute hospital settings - limited evidence of effectiveness
BMC Health Services Research 11:221 (2011)
http://www.biomedcentral.com/1472-6963/11/221
- studies were of low to moderate quality and of low evidence strength, with all but one having a high risk of bias
- studies suggest some benefits from checklists, but due to the risk of bias, results should be interpreted with caution
- More high quality studies are needed to establish effectiveness of safety checklists in acute hospital settings

Checklist value is not questioned in aviation, where the wheels can be forgotten up or down

Such checklists are likely an important but small component of earlier learning stages

The student is blocked by the perception of sufficient ease or speed to accomplish the task

Learners need ~40-50 hours of deliberate practice to achieve entry level competency with a typical skill set

Deliberate practice is a series of states with mechanisms for monitoring and guiding (feedback) future improvements of specific aspects of performance

Ericsson et al. Toward a Science of Exceptional Achievement Attaining Superior Performance through Deliberate Practice.
Ann NY Acad Sci 1137(1):109-137, 2009
http://onlinelibrary.wiley.com/doi/10.1196/annals.1393.001/full#f1
Improvement occurs between practice sessions in fast phase learning if interference isn’t present

Other conditions, such as stress states and sleep for consolidation, are critical to optimal learning

Once the skill becomes autonomous, conditions are less critical and long term retention occurs

Our first problem is that we can never have enough time or resources in a 4 year curriculum

Our second problem is that we can’t keep doing things the way we’ve been doing them

Maybe we need a different approach, such as the following:
Learning about learning improves learning

- As the need and opportunities for learning outside of formal classroom settings grow, knowing how to manage one's own learning is increasingly important.
- Learning, memory, and metacognitive process research provides evidence that people have faulty mental models of how they learn and remember, making them prone to both misassessing and mismanaging their learning.

Reviews:
- what learners need to understand to become effective stewards of their learning
- what people believe about how they learn
- research on how people's assessments of their learning are influenced by current performance and the subjective sense of fluency
- societal assumptions and attitudes that can be counterproductive for individuals becoming maximally effective learners.

UCLA Bjork Learning & Forgetting Lab
http://www.skepticalscience.com/print.php?n=1327

Paradigm shift from a static brain in mature adults to a neuroplastic brain has big implications

<table>
<thead>
<tr>
<th>Music</th>
<th>Planets, nonmusicians</th>
<th>GM WM</th>
<th>Higher GM density in sensorimotor cortex and cerebellum; higher FA in internal capsule</th>
</tr>
</thead>
<tbody>
<tr>
<td>Typing</td>
<td>Professional typists</td>
<td>GM</td>
<td>Positive correlation between typing experience and GM volume in the SMA, FPC, and cerebellum</td>
</tr>
<tr>
<td>Basketball</td>
<td>Basketball players, controls</td>
<td>GM</td>
<td>GM volume differences in the vermal lobule VI–VII of the cerebellum</td>
</tr>
<tr>
<td>Balancing</td>
<td>6 weeks' practice</td>
<td>GM WM</td>
<td>GM volume expansion in frontal and parietal brain areas as early as after two weekly practice sessions</td>
</tr>
<tr>
<td>Juggling</td>
<td>7 days' practice</td>
<td>GM</td>
<td>Increased GM density in MT/V5</td>
</tr>
<tr>
<td>Juggling</td>
<td>3 months' practice</td>
<td>GM</td>
<td>GM expansion in MT/VS and posterior intraparietal sulcus, followed by a decrease to baseline levels after 3 months with no practice</td>
</tr>
</tbody>
</table>

Neuron 72(3):443-454, 2011

Cognitive research informs how best to construct learning media


Neuroplastic brain develops complexity in response to environmental stimuli


These two cognitive systems differ in speed, function, and learning retention

<table>
<thead>
<tr>
<th>System 1: Thinking fast</th>
<th>System 2: Thinking slow</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Elephant</td>
<td>The Rider</td>
</tr>
<tr>
<td>Conscious self</td>
<td>Conscious self</td>
</tr>
<tr>
<td>Adaptive unconscious</td>
<td>Adaptive unconscious</td>
</tr>
<tr>
<td>Automatic, effortless, no sense of voluntary control</td>
<td>Deliberate, effortful, requires concentration</td>
</tr>
<tr>
<td>Habitual</td>
<td>Habitual</td>
</tr>
<tr>
<td>Emotion, intuition, “put feeling”</td>
<td>Ration, reasoning, logical</td>
</tr>
<tr>
<td>Implicit learning</td>
<td>Explicit learning</td>
</tr>
<tr>
<td>Impulsive, instinctual behavior</td>
<td>Controlled, often quenching impulses</td>
</tr>
<tr>
<td>Danger of Complacency</td>
<td>Danger of Inattention, Distraction</td>
</tr>
<tr>
<td>Ex: Highway driving</td>
<td>Ex: Parking</td>
</tr>
</tbody>
</table>


Our minds function roughly in two parts, conscious and subconscious

System 1: Subconscious Elephant
System 2: Conscious Rider

These proportions represent the cognitive processing balance

http://www.microbiologylab.com/glossary.html?g=327
Skills must be in System 1 to be retained

Recent lay press books cover new brain paradigm

Many such books are by researchers addressing their colleagues

Everyone’s first answers always come from subconscious, intuitive processing

Concepts pass from teacher’s consciousness through the students’ elephant to their conscious rider

Visual illusions are examples of System 1 processing

Cognitive reflection often does not occur when it should in decision making

- A bat and a ball cost $1.10 total. The bat costs $1.00 more than the ball. How much does the ball cost?
- If it takes 5 machines 5 minutes to make 5 widgets, how long would it take 100 machines to make 100 widgets?
- A lake has an growing patch of lily pads. Every day, the patch doubles in size. If it takes 48 days for the patch to cover the entire lake, how long would it take for the patch to cover half of the lake?

http://en.wikipedia.org/wiki/Caf%C3%A9_wall_illusion

http://pubs.aeaweb.org/doi/pdfplus/10.1257/089533005775196732
### The ball costs 5 cents

People who think the problem is easy are more likely to have the wrong answer.

The solution requires two algebraic equations:

- \( C_{\text{bat}} + C_{\text{ball}} = $1.10 \)
- \( C_{\text{bat}} = C_{\text{ball}} + $1.00 \)

Substituting:

- \( C_{\text{bat}} = $1.00 + C_{\text{ball}} = $1.10 \)

**Rearranging:**

- \( 2 \cdot C_{\text{ball}} = $0.10 \)
- \( C_{\text{ball}} = $0.05 \)

### The machines took 5 minutes to produce 100 widgets

An algebraic equation including a production rate is needed:

- \( \frac{\text{machines} \times \text{minutes} \times \text{widgets}}{\text{total widgets}} = total \text{widgets} \)

**Rearranging:**

- \( \frac{\text{minutes}}{\text{total widgets}} = \frac{\text{total widgets}}{\text{machines}} \)
- \( t = \frac{\text{total widgets}}{\text{machines}} = \frac{5 \text{ minutes}}{\text{machines}} \)

### One half the lake is covered in 47 days

The keys to the solution:

- Every day, the patch doubles in size
- If the patch covered the lake on day 48, the patch covered half the lake the day before

**Critical Lessons:**

- We have to learn to identify decisions for which "intuition runaway" is likely to be a problem
- We have to train our intuition if we want to process such decisions quickly, particularly when under stress
- To train our intuition, we have to generate self-feedback by checking our answers

### Human thinking is biased

"Human nature" is to:
- Weigh information consistent with current belief heavier
- Ignore or discount discordant information
- Search for belief-confirming data rather than belief-refuting data

- Prior belief biases observation by subtly changing perception, particularly of the vague or ambiguous
- Cognitive biases occur unconsciously and despite the observer’s best intentions!

**Critical Lessons:**

- We have to learn to identify decisions for which "intuition runaway" is likely to be a problem
- We have to train our intuition if we want to process such decisions quickly, particularly when under stress
- To train our intuition, we have to generate self-feedback by checking our answers

### Two major problems are the imperfect nature of our senses and our believing brain

We form our beliefs for subjective, personal, emotional, and psychological reasons in the context of environments created by family, friends, colleagues, culture, and society.

We defend, justify, and rationalize our beliefs with a host of intellectual reasons, cogent arguments, and rational explanations.

**Beliefs come first, explanations for beliefs follow**

Michael Shermer

### We have incredible, but flawed, sense-making capacity

"We try to make sense of the world, and in our brain nature has gifted us with a double-edge sword".

- "It is a complex and sophisticated information processing machine, capable of understanding not only the universe itself but of understanding the process of understanding"
- "By the same process of forming beliefs about how the universe works, we are most capable of self-deception and illusion, of fooling ourselves while we are trying to avoid being fooled by nature"
Should you believe it possible to be unbiased and completely rational, read one of the following:

- Influence
- Stumbling on Happiness
- Irrationally Irrational: Predictably Irrational: The hidden forces that shape our decisions

These remove any illusion...

Should you believe you are without bias, prove so with these on-line tests

Project Implicit
https://implicit.harvard.edu/implicit/

- “It is well known that people don’t always ‘speak their minds’, and it is suspected that people don’t always ‘know their minds’. Understanding such divergences is important to scientific psychology”
- “This web site presents a method that demonstrates the conscious-unconscious divergences much more convincingly than has been possible with previous methods. This new method is called the Implicit Association Test, or IAT for short”

The Alley slide format is alleged to increase student retention

The Assertion-Evidence Structure
http://writing.engr.psu.edu/slides.html

- Replacing a slide’s title with a sentence containing an assertion increases student retention