The Practice of Evidenced-Based Medical Education: Part I – Domains of Evidence

The application of evidence that underpins best practice raises three fundamental questions: (1) What is the evidence? (2) How does one select/evaluate the evidence? and, (3) How does one apply the evidence? We present a multi-part series to help educators and educational specialists organize and apply the plethora of related research and theory that may be used to practice evidenced-based medical education (EBME) starting with three DOMAINS of evidence. Distinguishing the domains helps answer Question 1. Guidelines from one published resource is included to characterize each domain. A bibliography of sample studies is provided separately to further distinguish the domains.

Domain 1. Learning Outcomes. Research and theory on achieving specified learning outcomes suggest that the design instruction should be based on what you want students to learn. Understanding outcomes serves as a starting point for guiding evidence-based educational practices.
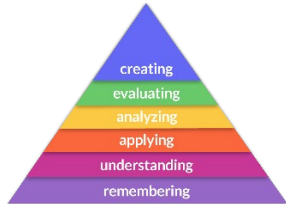

Figure 1. Updated Bloom's taxonomy of learning outcomes[1]

Applying Procedural Knowledge[2]
- Learn to *determine if/when procedure is required*. Provide correct answer feedback with learner controlled explanatory feedback.
- Learn to *list the steps in a procedure*.
- Learn to *complete the steps in a procedure*.
- Learn to *elaborate sequence*, starting with simple epitome of rule and elaborating to more complex versions of same rule.
- Learn to *check appropriateness of completed procedure*.

Domain 2. Learning Theories. Five major classes of theories have evolved over time to explain and predict human learning. The use of learning theories to guide EBME suggests that the underlying principles that govern how and why people learn transcend research and theory on desired learning outcomes and instructional approaches.
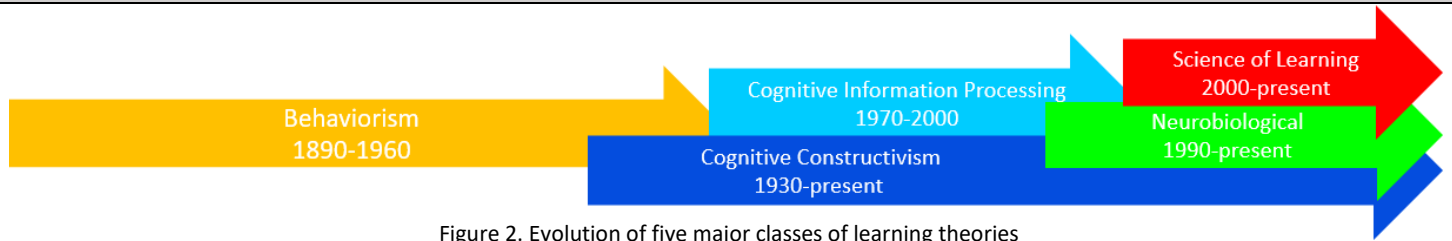

Figure 2. Evolution of five major classes of learning theories

Make it Stick: The Science of Successful Learning[3]

1. *Practice retrieval* by recalling facts and events to monitor progress, spot gaps, and adapt instruction to correct misconceptions.
2. *Space practice* to require the reconstruction of memory that reinforces meaning and promotes learning.
3. *Interleave practice* by mixing problem types, requirements, and procedures to engage different parts of the brain.
4. *Elaborating on* new information adds meaning by expressing ideas in personal terms and connecting it with what is already known.
5. *Reflection on learning* to retrieve memories, connect prior knowledge, and visualize behavior to promote mental rehearsal.
6. *Generate solutions* using prior knowledge and creativity to form and test answers, and learn from authentic experiences.
7. *Calibrate learning* to avoid illusions of mastery by assessing, and if necessary, remediating new and prior knowledge.
8. *Embrace difficulties* to broaden mastery by interleaving practice at different times, in different context, with different materials.
9. *Avoid undesirable difficulties* that can create anxiety, an aversion to risk-taking, and feelings of incompetence.
10. *Use and formulate mnemonics* to hold information in memory by using visualization and mental images to cue memories.

Domain 3. Instructional Approaches. Research and theory on different approaches to teaching and learning emphasize either the methods or the means used to facilitate learning. Methods may be teacher-directed or student-centered in nature, including but not limited to self, experiential, game-based, or active learning strategies. Means include, but are not limited to the use of conventional classrooms, simulations, online learning, blended learning, and virtual, mixed or augmented reality.

Figure 3. Figure 4. Simulation with VR goggles

Features and uses of high-fidelity medical simulations that lead to effective learning[4]
- *Feedback.* Knowledge of results of one's performance.
- *Repetitive practice.* Opportunity for learners to engage in focused, repetitive practice.
- *Curriculum integration.* Explicit strategy for integrating into medical school curriculum.
- *Range of difficulty level.* Engage in practice of medical skills across a wide range of difficulty levels.
- *Multiple learning strategies.* Large group with instructor, small-group with or without, or independent.
- *Capture clinical variation.* Expose learners to low frequency, high stakes patient problems.
- *Controlled environment.* Make, detect, and correct patient care errors without adverse consequences.
- *Individualized learning.* Adapt content and rate to individual learning needs.
- *Defined outcomes or benchmarks.* With tangible, objective measures defined at appropriate level.
- *Simulator validity.* Degree of fidelity provided to approximate situation, principles, and tasks.

An Illustrative Bibliography of Evidenced-Based Learning Resources

Domain 1 – Learning Outcomes

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Domain 2 – Learning Theories
Behaviorism
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