

TEACHING PHYSICIANS IN CLINICAL PRACTICE

How Have Teaching and Learning Advanced Beyond Traditional CME at The BioContinuum Group?

“Adult learning theory has become the standard by which continuing medical education is measured and appraised.”

[Cantillon, 1999]

After 15 years producing well-prepared, well-received medical education activities, and in response to advances in understanding how doctors learn, we at The BioContinuum Group have developed a new spectrum of activities to better educate practicing physicians. Specifically, we are applying accepted theory on adult learning, emerging findings on medical professionalism, and models of learning in clinical practice to design, implement, and evaluate instruction that changes how physicians practice in a way that can be documented.

This article describes how our unique new procedures help clients address problems they face when teaching physicians in clinical practice. Here we present three of these problems (and, in the Appendix, how we address them) followed by the instructional theory we have synthesized from theories of adult learning, medical professionalism, and clinical learning models.

What Problems Do We Address for Our Clients?

“CME is...the rare industry where a significant gulf exists between...demand and the product developed to support that demand.”

[Armstrong, 2005]

We bridge the gulf that Armstrong identified in addressing problems for our clients such as:

1. Physicians at your educational events say that these do not provide solutions to the clinical problems they face. Because CME credit is widely available, physicians say that what they really want are solutions to problems *they really* confront, which are neither what those speakers talk about nor are covered by the theoretical issues raised. *The problem is how to make instructional content relevant—and therefore compelling—to physician learners?*
2. Accreditation bodies and funding organizations with which you work doubt that doctors come away with anything more than CME credit. They ask you to document the learning realized at your programs despite meta-analyses of learning that show changing physician behavior requires multiple educational interventions. *The problem is how to document whether learners’ changes are attributable to individual instructional interventions?*
3. You know that more effective educational approaches are out there, but you are not certain which are worth the investment. Because CME programs *are* an investment, the resources you put into them must pay dividends in terms of changed physician behaviors. *The problem is how can better instructional activities be identified and evaluated?*

The BioContinuum Group addresses these problems based on our integration of the research on (1) *how adults learn generally*, (2) *how doctors learn in clinical practice specifically*, and (3) *how learning occurs within the constraints of the medical profession*.

What Does Adult Learning Theory Say About How to Teach Doctors?

The andragogical teacher...prepares in advance a set of procedures for involving the learners...[including] diagnosing the needs for learning...[and] formulating program objectives that will satisfy these needs....

[Knowles, Holton, and Swanson, 2005]

Of the multiple and overlapping sets of ‘principles of adult learning’ available (Knowles, et al., 2005), the set we use focuses on instructional design (Slotnick, 1996). It says:

1. Adults want to learn solutions to problems they already have (and, conversely, they seldom learn solutions to problems they do not have).
2. Adults want to participate in their own learning.
3. Instruction for adults must respect the multiple demands in their lives.

The first principle has us identifying problems (1) that attract learners’ attention, and (2) that we use to introduce and structure learning activities. The second requires that we provide learners with *experiences* (e.g., activities that identify the problems, then introduce and demonstrate the skills and knowledge needed to resolve the problems) they can think about and so realize insights into both the problems and their solutions. Indeed, participation lies at the heart of learning: *Learning* is the *process of reflecting on experience, that reflection producing insights that may be useful in solving future problems* (Slotnick, 1999).

The third principle requires that (1) learning should minimally interfere with other aspects of learners’ lives, and (2) maximize the different ways in which learners can use what they have learned.

How Is Physician Learning Different from What the Rest of Us Do?

“Learning in a profession is unlike any other kind of learning.”

[Grant, 2002]

“Medicine is a profession with inherent unpredictability and uncertainty.”

[Grant, 2002]

Instruction for physicians—*as professionals*—differs from that for other adults because professions differ from other occupations. First, professionals address more complex problems for their clients than do practitioners in other occupations (Hilton & Slotnick, 2006). Second, the knowledge and skills professionals use in addressing these problems are esoteric, require prolonged, supervised training, and can be harmful if used incorrectly. Third, and finally, professionals must develop cognitive skills and ethical reasoning abilities not required of other occupations and then apply those skills and knowledge in handling complex problems. These differences suggest that the principles of adult learning must be customized to teach physicians.

In contrast to practitioners in other occupations, professionals solve *ill-structured problems* (Slotnick and Hilton, 2007). Such problems are often ambiguous (e.g., shortness of breath can indicate everything from exertion to a pulmonary embolism), commonly have no apparent solution or multiple competing solutions, and regularly attract stakeholders holding different and even competing stakes.

Physicians-in-training learn to cope with ill-structured problems as they learn to use medical knowledge, medical skills, and *materia medica*. They develop sophisticated cognitive skills (including using Aristotelian, Boolean, and statistical logic) to see things from others’ viewpoints; this is known as *principled ethical reasoning* (Bruner, 1990).

Approaching ill-structured problems using sophisticated cognitive skills, and considering others’ perspectives using principled ethical reasoning, underlies the principles of instruction arising from adult learning for medical professionals. Principle 1 now asserts that helping doctors learn to solve

complex problems means helping them identify salient ambiguities, cast relevant hypotheses, and identify the stakeholders involved.

Principle 2 clarifies that participation in instruction for professionals can require that doctors use sophisticated cognitive and ethical reasoning in learning to solve problems they face. This also means that because the problems are ill-structured and require sophisticated thinking, simply describing approaches to problems to doctors is insufficient. Learners must be involved actively both with the problems and their solutions so that they can experience what solving these problems is like.

Principle 3, which holds that instruction must be respectful of learners' time, refers to instructional efficiency and requires (1) attending carefully to the first two principles, since doing so will focus doctors' attentions and so increase how much doctors learn per unit time, and (2) providing differing examples to work through so doctors can experience the range of problems they can now solve and appreciate how the solutions may vary in each case. Such meaningful engagement with learners clarifies ambiguities, makes hypotheses and their evaluation more understandable, and offers insights into the stakeholders' positions and so how best to approach them. Fundamentally, one understands things better after one has experienced them.

How Do Physicians Learn in Clinical Practice?

“...seeking information for solving a problem is the midpoint in a multifaceted, dynamic process that begins with problem recognition and ends with problem resolution.”

[Haug, 1997]

Studies of how doctors learn from print, colleagues, and on-line resources suggest that once doctors are satisfied with a learning resource (they describe it as familiar, accessible, and time-efficient), they are disinclined to try other similar resources (Shershneva, Slotnick, and Mejicano, 2005). Our instruction will thus be most successful if we ask doctors to use resources they turn to regularly in clinical practice.

Learning in clinical practice is *episodic* (i.e., it follows a series of stages appearing in the same order) (Geertsma, Whitborne, and Parker, 1982; Putnam and Campbell, 1987; Slotnick, 1999). Not surprisingly, different things take place at each stage, further qualifying the principles of learning. An ill-structured clinical problem can be broken down into a different *subproblem* at each stage in a learning episode. Because the stage-specific subproblems (SSPs) vary, the experiences and the reflection applied to those experiences varies from learning stage to learning stage.

Stage 0 in a learning episode is called *scanning* and its stage-specific subproblem is *detecting a problem the doctor may need to resolve*. This is the ‘basal’ stage for doctors because solving patients’ problems is how they earn their livings. The problems physicians face appear as discrepancies between ‘what is’ and ‘what should be’ (Dewey, 1910). These can be identified immediately (e.g., from a patient’s complaint) or detected, such as when a doctor intuits that something is wrong from test results. This stage ends when a potential problem is detected.

Evaluation is Stage 1 and its stage-specific subproblem is ‘should I take on this problem?’ This is when doctors evaluate potential problems and decide whether to pursue them by acting as if they are asking and answering four questions (Slotnick, 1999):

1. Is this a problem for me? Physicians will not pursue problems that will clear up on their own or that are best handled by referral to another doctor.

2. Does the problem likely have a solution? Physicians will not pursue problems they think have no solution (Gorman, 1995) because they will not waste time on futile searches.
3. Are resources available to find the solution? Resources called upon include demands on a physician's own time and the availability of learning resources—especially those well known to the learner.
4. Will learning the solution improve my practice and, conversely, will not learning the solution threaten my practice? This question includes considerations such as whether learning to solve the problem will increase the number of evenings the doctor gets home before 8:00 pm or the potential loss of income if he does not learn some new skill or knowledge.

Importantly, answering all four questions 'yes' means that learning has been 'triggered.' From the perspective of motivating a doctor to learn to solve a problem, anything that changes a 'no' to a 'yes' is a triggering event (Fox, Mazmanian, and Putnam, 1989) that creates a *teachable moment* (Leist, 1990). Thus triggering events move doctors to Stage 2.

Stage 2 is *learning*, and its stage-specific subproblem is 'how do I gain the skills and knowledge needed to solve the problem?' The issues in this stage are: knowing the learning resources doctors use (since, as noted, they are disinclined to consider resources they do not usually use) and how much a doctor must learn before he decides he knows enough to implement the problem's solution. This is important because doctors do not read and consult *ad infinitum*; they read and talk with colleagues only until they are satisfied that they know what to do (Slotnick, 2000). In other words, relying on learning resources doctors already use and ensuring that instruction trips one or more stopping rules decreases instructional time and increases the likelihood doctors will know how to solve the problem at hand.

Finally, Stage 3 is *gaining experience*, and its stage-specific subproblem is 'becoming comfortable and confident using new skills and knowledge.' As noted, activities at this stage expose the learner to the range of problems addressable with the new skills and knowledge and the range of complications associated with using them as they reflect both in the moment and afterwards (Schön, 1982).

Physicians enter this stage acutely aware of their actions in using the new skills and knowledge but

not confident in their abilities. It is not that what they are doing is somehow wrong; they simply lack the confidence born of experience. Conversely, they end the stage confidently using what they have learned.

Gaining experience is the point where new clinical behaviors can be observed in clinical practice. Thus, even though learners must move through three stages before changed behavior can be expected, looking only for changed behavior misses most of the learning needed to reach that point.

The way physicians learn in clinical practice further qualifies the principles of adult learning.

Principle 1, that physicians want to learn solutions to ill-structured problems they already have, can be further clarified by noting the stage-specific subproblem each physician is facing. Not knowing the stage-specific subproblem risks instructional failure because *doctors seldom learn solutions to problems they do not have*. For example, a doctor with an *unperceived need* (i.e., he does not know how to properly handle a clinical problem but thinks he does) is at the evaluation stage when he should be at the learning stage. Showing him what is needed to handle the problem fails because he does not believe he needs to learn those new skills and knowledge. Instead, we should present him with appropriate evaluation-stage activities (i.e., experiences bearing on the three evaluation-stage questions that lead to reflection) so he can decide he wants to learn the solution to a given clinical problem. To address the doctor's clinical problems, then, instruction must identify and satisfy both the clinical problems learners face and the stage-specific subproblem appropriate to each doctor's stage of learning vis-à-vis the problem.

Thus the nature of the physician learner's engagement with the instructional content changes from stage to stage. Scanning, for example, may be intuitive while evaluation involves doctors reading and talking with others. Learning has them doing things (often under a colleague's supervision). Gaining experience sees them figuring out how to apply what they have learned. At all stages, doctors have experiences and reflect on them; what makes stages different from one another is the nature of the experiences and so the insights that reflection produces.

Table 1. Summary of the stages of learning.

Stage	Stage-Specific Problem	Instructional Content
1. Evaluation.	Deciding whether to take on the problem in question.	Instruction covers: Is this a problem for me? Is there likely a solution to the problem? Are resources available to learn the solution? And will learning to solve the problem improve my practice OR will not learning to solve it damage my practice? Engagement in learning requires using ‘materials’ (e.g., problems, reading, discussion) that the learner can relate to and then facilitating the doctor’s reflection on the experience or working so that he can realize the insight that he needs to learn to solve the clinical problem at hand.
2. Learning.	Learning the skills and knowledge needed to resolve the problem.	Instruction includes reading, conversation, and hands-on activities in the case of psychomotor skills. Engagement includes reading and conversation with the focus on the skills and knowledge needed. Supervised hands-on experience may be necessary when the doctor is learning skills. Conversation under these circumstances engages the learner in reflection on what is happening as he tries out the skills (called <i>reflection-in-action</i>) and after he is finished (called <i>reflection-on-action</i>) (Schön, 1989). In both cases, the goal is insights that will facilitate both continued learning and application after learning is over.
3. Gaining experience.	Becoming comfortable and confident using the new skills and knowledge.	Instruction allows doctors to learn the range of problems addressable using the new skills and knowledge, and how to handle difficulties arising during their use. Content here includes problems and their various solutions. Engagement requires the instructor to support the learner by asking the doctor to identify ways in which the observed outcomes are (or are not) consistent with what is expected, and guidance in identifying insights useful in handling both the range of problems and the difficulties encountered in the future.

Dealing with multiple demands on doctors’ time can be clarified in two ways. First, knowledge of the learning resources individual doctors use and the stopping rules appropriate at each stage allow an instructional design that takes as little time as possible so that learners are more available to do other things.

Second, attention to instruction at the gaining experience stage increases the likelihood that learning done at other stages will be used. Educational psychologists have long known that knowledge of how to do something does not mean recognition of all the circumstances under which that knowledge can be used (Thorndike, 1910). Thus engaging physicians with the range of solvable problems increases the likelihood they will use what they have learned without needing a learning episode for each new application.

How Do We Apply the Principles of Learning?

"It is impossible for a man to learn what he thinks he already knows."

[Epictetus, 55-135 AD]

In light of the preceding discussion, the principles of learning The BioContinuum Group uses in teaching physicians in clinical practice can be summarized as:

1. **Physicians want to learn solutions to the (often ill-structured) problems they face.** In doing so, each physician wants to learn the solution to the specific learning stage subproblem appropriate to where he is vis-à-vis the clinical problem in question.
2. **Physicians want to participate in their own learning through active involvement with both instructional materials and the problem itself.** This involvement includes both: (a) experience with the problem's ambiguities, the hypotheses considered in approaching the problem, and the stakeholders (and their stakes) in the problem and its possible solutions; and (b) reflection on those experiences so doctors can realize insights into the problem and its solution(s).
3. **Instruction must respect the multiple demands on physicians' time.** This is met by being time-efficient and teaching the range of ways in which the skills and knowledge that are taught can be used.

How Is Instruction Properly Planned?

The BioContinuum Group believes instruction is the process of planning, implementing, and evaluating activities that provide experiences and guide reflection. In this way learners can realize insights into problems that they face and solutions to those problems.

To accomplish this, we must:

- Identify clinical problems important to physicians, including the stage-specific subproblems for each learner for each problem.
- Identify the experiences and insights required of learners to participate successfully in the instruction—including experiences learners should have before instruction begins as well as those they will have during instruction.
- Identify the insights expected upon completion of instruction so learners can move from their current stage to the next one.
- Identify the occasions for and varieties of reflection needed to produce the desired insights.
- Once identified, we expect to document physician learners' experiences, the nature of their reflections on those experiences, and their insights as embodied in their changed knowledge and skills, their movement from stage to stage, and additional realizations specific to each learner.

How Are Clinical Problems of Importance to Learners Identified?

“Relying on doctors to identify their own learning needs...may be problematical...”

[Cantillon, 1999]

Needs assessment activities document the population of learners’ learning needs. While it might seem that all that is needed is to ask learners what they do and do not know, the literature reports a tenuous relationship between what doctors know and what they think they know (Davis, 2006). Therefore, we have taken another approach to identifying physicians’ learning needs.

We believe doctors are better at identifying the kinds of problems they face than they are at identifying their learning needs. Therefore our approach to identifying learning needs begins with physicians identifying problems they face (or can see themselves facing) and, with those problems identified, asking key opinion leaders to indicate the knowledge and skills needed to handle them.

The process is straightforward. Once the client tells us the therapeutic area of interest (e.g., GERD, adjuvant therapy in stage II colon cancer, etc.), we convene a panel of physicians conversant with this therapeutic area. Using Nominal Group Process (NGP) (DelBecq, Van de Ven, and Gustafson, 1975), the panel produces a prioritized list of clinical problem types that we call *domains* within which physicians should be able to work unaided. We then ask panel members to write *clinical vignettes*, with each vignette describing a clinical problem falling under the most important problem domains.

How Are Stage-Specific Problems Identified?

“...physicians are motivated to begin learning either by specific problems (e.g., questions raised about particular patients) or by general problems (e.g., gaps in skills and knowledge caused, say, by updated techniques and new technologies)...”

[Slotnick, 1999]

The most important vignettes become multiple choice questions in the needs assessment survey instrument sent to members of the physician-learner population. Options used with the questions appear in Table 2 and indicate which stage of learning a respondent is at *and not* how the doctor would handle the problem in the vignette. This is especially important in cases when physicians have *unperceived needs*—defined to mean physicians think they have the skills and knowledge to handle the problem in the vignette though they do not. These physicians have an *unperceived need* because they think they are at the evaluation stage (where they are deciding when next to update themselves) when, in fact, they should be at the learning stage.

Table 2. Options for clinical vignettes in the needs assessment survey instrument.

Option	Stage	Comments
I wouldn't see a patient like this one.		The number of respondents selecting this option reflects how appropriate the problem is to the physician population.
I'm confident I can handle the problem in the vignette. The only thing I might be interested in learning is information helping me decide when next to update my skills and knowledge in this area.	Evaluation	Learners selecting this option may be doing so inappropriately because they in fact need to update. They are said to have an <i>unperceived need</i> .
I need to update my skills and knowledge so that I can handle the problem in the vignette.	Learning	Learners selecting this option are said to have a <i>perceived need</i> .
I've recently updated my skills and knowledge in the area. The only thing I might be interested in is hearing others' experiences handling these kinds of problems.	Gaining Experience	Learning about others' experiences is one way people have of learning to deal with uncertainty.

The survey instrument (i.e., directions and the vignettes each followed by the Table 2 options) is then given to a representative sample of physicians of interest to the client. Survey results estimate the percentage of physicians at each stage for each clinical problem. The percentage of people selecting the learning stage option tells us the approximate number in the population having a *perceived need*—that is, the number who need an update so they can better treat problems like those in the vignette.

The estimated percentage of doctors with *unperceived needs* (doctors believing they do not need an update when in fact they do) is identified through *triangulation* (Lockyer, 2005). Triangulation means using two sources of information to look at one issue—in the case under discussion, the percentage of physicians reporting they can handle a problem, plus an independent assessment (such as evidence from chart reviews) capable of indicating whether the doctors are inappropriately sanguine.

How Is Instruction Prepared Once Learning Needs Are Identified?

*"Instructional design requires answering two major questions:
What to teach? And how to teach it?"*

[Merrill, 1998]

The instructional process we describe here involves either remote, self-directed learning (e.g., computers, Internet, or print) or face-to-face instruction which is particularly well suited to small-group learning. Both formats are applicable regardless of whether needs assessment indicates learners have perceived or unperceived learning needs.

Since we believe that learning is the process of realizing insights through reflecting on experience, instruction involves ensuring that learners have both the required experiences and guided opportunities to reflect on them. Therefore, planning and implementing instruction means identifying and providing experiences for learners and then supporting their reflection on those experiences. This is true whether the learning needs are perceived or unperceived.

Because learners with perceived needs are at the learning stage and want to learn the skills and knowledge needed to solve the clinical problem at hand, instructional experiences should cover what they need to know to resolve the problem. Further, opportunities to reflect should allow learners (1) to relate what they are learning to what they already know and (2) to see how they can apply what they have learned.

We address both these goals by introducing a clinical problem similar to the ones learners are interested in learning to solve. The way we present the problem allows the learner to begin thinking about the solution and offers the learner questions whose answers can clarify the problem at hand as learners think about it and use the insights they gain to consider possible solutions.

Learners who have unperceived needs differ from those with perceived needs because the former group does not expect to have difficulty dealing with the problem at hand. This is important because physicians seldom learn solutions to problems they do not recognize they have.

What problems will interest learners with unperceived needs?

The short answer is that we offer them a surrogate problem, which they will be likely to take on, such as asking them to help a colleague who is having difficulties. Our goal is to change their perception from an unperceived to a perceived learning need. We do this by relying on their learning answers to the evaluation-stage stage-specific subproblems in a manner that is *incidental* to the problem they are formally addressing. We expect doctors will look at their colleague's problem and realize that, 'I would have made the same mistake because that is the way I do things, too.' They may then decide that they need to update their skills and knowledge to address the problem at hand.

How Is Instruction Evaluated?

"...evaluation remains an important part of the educational cycle."

[Cantillon, 1999]

An evaluator's first task is deciding which goals to address because evaluative goals can interfere with each other. If the goal is to estimate how much of learning can be attributed to the instructional intervention, we recommend the use of a control group receiving a null treatment. We more commonly encourage clients to skip the control group and use pre- and posttests as part of the instructional intervention. Our logic is that pretesting serves to *prime* learners by having them call into short-term memory the concepts and principles they will need to consider for what is to be taught (Meyer and Kornblum, 1993). Posttesting is the first time learners can review what they have learned.

We encourage our clients to consider three different outcomes measures in evaluating learning activities: stage-to-stage movement, change in knowledge and skills, and identification of what learners considered important during instruction. In the first case, we use a measurement tool presenting learners with clinical problems similar to the ones they will learn about and asking them to indicate their stage of learning using the set of options in Table 2. The same instrument is then used as a posttest so that we can measure how many people moved from their pretest learning stage to the next stage (Moore and Slotnick, 2006).

The second approach also presents clinical vignettes, but these are followed by a handful of questions with options indicating how learners will approach the problem presented. Pre- and posttesting this way allows documentation of any gain in knowledge.

Finally, we use *minute reports* (Mosteller, 1989) to document learners' self-reported and open-ended perceptions of what they gained from the instructional activity. Queries on minute reports vary according to the client's needs and often include questions such as:

1. What are the most important things you learned at this session?
2. What topics covered would you like to know more about?

3. What topics covered remain unclear to you?

Tabulating the number of learners whose observations are similar allows us to identify those that were likely representative of the entire learner group.

Summing Up...

Our goal is to help our clients address their needs through the instruction of physicians, helping them learn solutions to problems that they have. Our instructional design is grounded in accepted principles of adult learning, the realities of medicine as a profession, and the ways physicians learn in clinical practice. We do this because our clients know that if physicians can manage the clinical problems they face more efficiently, they will use the time and energy freed up to address other demands they face.

Appendix

Solutions to the Three Problems

"...in medicine, the problems are generally undesirable so that when a physician is successful, he brings the patient from something bad (a state of illness) to something good (a state of health)...."

[Slotnick, Mejjicano, Passin, and Bailey, 2002]

We apply two tactics to the three clients' problems that began this paper on our approach to learning.

The first problem was with physicians who did not perceive solutions to the clinical problems they face. This addresses the goal of making instruction relevant—and so compelling—to the learners. The solution to this problem relies on the fact that physicians, as adults, want to learn to solve problems they already have. This means that identifying their problems goes a long way toward ensuring relevance. We have described how this is done using NGP and vignettes to determine not only clinical problems of importance to learners, but also the stage-specific subproblems learners have. Knowing these two elements comes very close to being sufficient as a mechanism for identifying what doctors want to learn because, in the first case, the problem addressed is important, while in the second, the theory of physician learning indicates what needs to be taught to learners at each stage of learning.

Presenting stage-specific information not only satisfies learners' needs, but also is central to resolution of the second problem at the beginning of this paper. That problem concerns the need to document what learners gain from attending educational activities. This problem is exacerbated by the fact that single educational activities seldom result in changed learner behavior. Our next point is that it is possible to document some movement toward changed behavior, which takes the form of progress from one stage of learning to the next. The theory we propose specifies what is to be learned at each stage and the 'stopping rules' doctors use to decide when they have learned enough to move on to the next stage. We can document movement both through the self-report of learning status and achievement test performance to demonstrate that learning was successful.

The third and final problem concerned identification of instructional approaches showing promise of being useful. Beyond the fact that instruction must be problem-based, we suggest that such techniques will fall at the intersection of the other two instructional principles: adults want to participate in their own learning and instruction must be respectful of the multiple demands on learners.

What instructional techniques satisfy these principles? They include the use of problem-solving activities, particularly when the problems addressed are documented to be important to learners. These problems can be presented in many creative ways, such as games and computer simulations. The key in using these methods is to ensure that instructors facilitate learning by providing experiences learners need and guiding reflection on those experiences so appropriate insights can be realized.

Suggested Readings

- Armstrong E, Parsa-Parsi R. How can physicians' learning styles drive educational planning? *Acad Med.* 2005;80:680-684.
- Bruner JS. *Acts of meaning.* Cambridge, MA: Harvard University Press; 1990.
- Cantillon P, Jones R. Does continuing medical education in general practice make a difference? *BMJ.* 1999;318:1276-1279.
- Cruess SR, Johnston S, Cruess RL. "Profession": a working definition for medical educators. *Teach Learn Med.* 2004;16:74-76. [Abstract]
- Davis D, O'Brien MAT, Freemantle N, Wolf FM, Mazmanian P, Taylor-Vaisey A. Impact of formal continuing medical education. *JAMA.* 1999;282:867-874.
- Davis DA, Mazmanian PE, Fordis M, Van Harrison R, Thorpe KE, Perrier L. Accuracy of physician self-assessment compared with observed measures of competence: a systematic review. *JAMA.* 2006;296:1094-1102. [Abstract]
- Delbecq AL, Van de Ven AH, David H, Gustafson DH. *Group techniques for program planning: a guide to nominal group and delphi processes.* Glenview, Ill.; Scott-Foresman and Company: 1975.
- Dewey J. *How we think.* Lexington, Mass.: D.C. Heath; 1910.
- Edwards A, Matthews MR, Matthews S, Houston H, Wilkinson C. General practitioners' self assessment of knowledge. *BMJ.* 1998;316:1609.
- Fox RD, Mazmanian PM, Putnam RW, eds. *Changing and learning in the lives of physicians.* New York: Praeger, 1989.
- Geertsma RH, Parker RC, Whitbourne SK. How physicians view the process of change in their practice behavior. *J Med Education.* 1982;57:752-761.
- Gorman PN, Helfand M. Information seeking primary care: how physicians choose which clinical questions to pursue and which to leave unanswered. *Medical Decision Making.* 1995;15:113-119.
- Grant J. Learning needs assessment: assessing the need. *BMJ.* 2002;324:156-159.
- Hilton SR, Slotnick HB. Proto-professionalism: how professionalisation occurs across the continuum of medical education. *Med Educ.* 2005;39:58-65.
- Knowles MS, Holton EF III, Swanson RA. *The adult learner.* 6th ed. Amsterdam, the Netherlands: Elsevier; 2005.

- Leist JC, Kristofco RE. The changing paradigm for continuing medical education: impact of information on the teachable moment. *Bull Med Libr Assoc.* 1990;78:173-179.
- Lockyer J. Needs assessment: lessons learned. *J Contin Educ Health Prof.* 2005;18:190-192.
- Mazmanian PE, Davis DA. Continuing medical education and the physician as a learner: guide to the evidence. *JAMA.* 2002;288:1057-1060.
- Merrill MD. Chapter 17, in Reigeluth CM, ed. *Instructional-design theories and models: a new paradigm of instructional theory.* Mahwah, NJ: Lawrence Erlbaum Associates, 1999.
- Meyer DE, Kornblum S (eds). *Attention and performance XIV: synergies in experimental psychology, artificial intelligence, and cognitive neuroscience.* Cambridge, Massachusetts: The MIT Press: 1993.
- Moore J, Slotnick HB. Documenting the impact of formal education on clinician change. *CE Measure.* 2006;1:11-16.
- Mosteller F. The "muddiest point in the lecture" as a feedback device. *On Teaching and Learning.* 1989;3: 39-46.
- Robertson K. Reflection in professional practice and education. *Austral Fam Physician.* 2005;34:781-783.
- Schön DA. *The Reflective Practitioner.* New York: Basic Books, 1983.
- Shershneva MB, Slotnick HB, Mejicano GC. Learning to use learning resources during medical school and residency. *J Med Libr Assoc.* 2005;93:263-270.
- Slotnick HB. How doctors learn: the role of clinical problems across the medical-school-to-practice continuum. *Acad Med.* 1996;71:18-34. [Abstract]
- Slotnick HB. How doctors learn: physicians' self-directed learning episodes. *Acad Med.* 1999;74:1106-1117.
- Slotnick HB. Physicians' learning strategies. *Chest.* 2000;118:18S-23S.
- Slotnick HB, Hilton SR. Proto-professionalism and the dissecting laboratory. *Clin Anat.* 2006;19:429-436.
- Thorndike EL. The contribution of psychology to education. *J Educ Psychology.* 1910;1:5-12.