Schema-Based Learning (S-BL)

Educators use the term "schema" to describe the way in which people organize and "store in memory" what they know about the world. Studies of clinical decision-making have indicated that highly experienced clinicians think differently about problems than do their residents, or even their less experienced colleagues. It is not just that they know more (though they do), it is that their knowledge is organized in a way that makes it readily accessible for solving problems. In medicine, clinical schemas have been likened to integrated networks composed of clinical and scientific knowledge that is interwoven with knowledge of human behavior, economics and/or any other discipline that may be meaningful for solving problems.

Even the terminology and categories that experienced clinicians use to describe problems are more generalized and efficient. In the "experts' schemas, knowledge appears to be organized at an abstract level, with descriptions of particular instances "translated" into broad categorical terms. These broad inclusive terms provide a sort of "short hand" for recognizing and describing patterns. In fact, these terms are often combined to create "rules of practice" that make problem solving efficient. (Click to view example or see Attachment 1)

Because expertise is gained over years of practice, most experts are not fully aware of their own "mental networks" and as a result rarely refer to these organizational structures when teaching. Schema-based Learning is grounded in capturing and using expert-generated schemas as frameworks for teaching and learning. Schema-based diagrams (SB-D) are the product of guiding an expert in thinking about their own "mental models". The following key characteristics of schema-based learning are consistent with the characteristics associated with "Teaching from a Competency Perspective".

- The schemas of experienced clinicians can be captured and represented on paper as schema-based diagrams (S-BD) and can be used as an organizational foundation for lectures, problem-based clinical conferences and/or clinic and bedside teaching. (Real-life)

- By using S-BDs in teaching, faculty promote resident self-assessment and accountability, through the modeling of the reflective/critical review process. In addition, framing new learning through the discussion of S-BDs grounds the instruction in real-life clinical problems.

Example 1

Use of a SB-D in Teaching

Scenario: A faculty-generated schema-based diagram (S-BD) is used in a weekly lecture series to teach and help organize medical knowledge and inform patient care practices.

You are the residency director for a large university-based Dermatology Residency Program and are considering changing the weekly lecture series to include faculty-generated schema as the organizational foundation for the lecture series. Currently, topics are drawn from a list of pertinent diagnoses in dermatology. Interest by faculty and residents has been diminishing and residents do not appear to be engaged in the process.

The illustration below describes how you can address Patient Care, Medical Knowledge and Practice-Based Learning and Improvement objectives by using a faculty generated schema-based diagram during a group seminar. The **objectives** of this learning activity are that residents will be able to 1) efficiently obtain, organize, and apply new clinical information (*Medical Knowledge and Patient Care*); 2) assess their learning needs by comparing current knowledge against schema diagrams generated by experienced clinicians (*Practice-Based Learning and Improvement*).

Illustration:

In this illustration, a schema-based diagram was developed for the differential diagnosis for Dermatofibrosarcoma protuberans (DFSP). DFSP was introduced to the residents through review of the faculty-generated schema diagram and a short discussion of the clinical reasoning that lead to the differential. Discussion of the topic of the day took the next 30 minutes. At the conclusion, residents were asked to go back to the diagram and ask questions about any one of the categorical links in the clinical reasoning process. (http://www.academic.mco.edu/curriculum/presentations/openp4.html to view animated schema for this example)

Using the faculty generated schema-based diagram as a model, residents could be asked to generate their own diagram based on their understanding of a similar problem. (Click to view a discussion on learning from S-BD's or see Attachment 2.)

Example 2

Developing a Schema-based Diagram While Teaching

Scenario: The process of generating schema-based diagram (S-BD) can be used to reflect on practice-based knowledge and skills and refocus teaching to improve patient care.

You are an associate residency director for a large community-based Internal Medicine residency program and learned about Schema-based Learning at an educational conference. You decide to try to generate an S-BD to enhance your teaching in the ambulatory setting. You feel that you sometimes focus too much on “scientific information” and not enough on practice-based knowledge and skills.

The illustration below describes how you can promote Patient Care, Medical Knowledge, and Practice-Based Learning and Improvement by using a schema-based diagram to elaborate on the “wisdom of practice”. The **learning objectives** are that residents will (a) be exposed to methodologies (reflection and schema construction) for assessing their own knowledge and clinical thinking (*Practice-Based Learning and Improvement*); and (b) acquire new clinical knowledge about patients and its application to clinical decision-making. *(Medical Knowledge and Patient Care)*

Illustration:

The process of generating a S-BD can help experienced clinicians bring to a conscious level much of the practice-based learning they have gained through experience. In this illustration the associate residency director has had a patient encounter video-taped. She asked that one of the medical educators from the dean’s office view the tape with her. During the viewing of the video, the educator asked her questions about what she was thinking during different segments of the history and physical. At the end of the interview the educator reviewed with her the list of practice-based capabilities and categorical terms that she used in describing her thoughts about the patient encounter. From that list, she selected two of these features to further elaborate. One of the categorical terms she used described the patient as a “poor historian” (click to see historian S-BD or see Attachment 3). The second feature she chose focused on the capability of “enlisting family members to support the patient when needed” (click to see family S-BD or see Attachment 4). She repeated the process of viewing the videotape with a group of residents during a noon conference. She shared with the residents her “discovery” of the two practice-based capabilities that had been highlighted through this reflective process. Together with the residents she generated a SB-D for each. By reflecting on her own practice and making explicit what had previously been tacit or hidden, the associate residency director models reflective practice, teaches residents to value practice-based knowledge and skills and employ those skills in caring for their patients.

Tips for Using Schema-based Learning (SBL)

As you can see from our two examples, schemas can be developed to promote the acquisition of new scientific knowledge as well as practice-based knowledge and skills. S-BD can be generated by faculty with experience and expertise in any number of critical knowledge or skill areas. Although, examining our own schemas is not easy, the rewards can be great. Initially, help from a medical educator or colleague can be invaluable.

1 When presenting S-BD to residents as a foundation for discussion, engage the residents in an analysis of the assumptions on which the categories or relational links were based. Often these assumptions are kept private and residents are reluctant to question their teachers at this level. By fostering discussion, you are modeling critical reflection and encouraging residents to be prepared to do the same.

1. When using S-BD as an organizational strategy for a lecture, keep the diagram in view so that the audience can refer to all of portions of it as the lecture proceeds.

2. Schemas can be generated in a more informal way by encouraging faculty to “think aloud” as they perform any clinical task. This can be also accomplished through faculty interactions with simulated patients. (click here to view two methods for generating S-BD’s or see Attachment 5)

3. When residents become accustomed to the use of S-BD, ask them to generate their own before and after a lecture or discussion. This is one way to promote resident self-assessment and gain insight into the usefulness of the session. Residents could critique and learn from the SB-D’s of other residents by comparing and contrasting features and links. You can also have residents collaborate on generating a schema diagram.

Key References (click to view)

Selected References for Schema-Based Learning

1. Derry SJ. Cognitive schema theory in the constructivist debate. *Educational Psychologist* 1996;31(3/4):163-174.

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3. Mandin H, Jones A, Woloschuk W, Harasym P. Helping students learn to think like experts when solving clinical problems. *Academic Medicine* 1997;72(3):173-179.

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5. Reynolds RE, Sinatra GM, Jetton TL. Views of knowledge acquisition and representation: A continuum form experience centered to mind centered. *Educational Psychologist* 1996;31(2):93-104.

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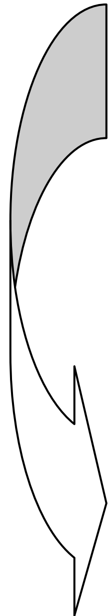
7. Van de Weil MWJ, Boshuizen HPA, Schmidt HG. Knowledge restructuring in expertise development: Evidence from pathophysiological representations of clinical cases by students and physicians. *European Journal of cognitive Psychology* 2000;12(3):323-355.

8. Woloschuk W, Harasym P, Mandin H, Jones A. Use of scheme-based problem solving: an evaluation of the implementation and utilization of schemes in a clinical presentation curriculum. *Medical Education* 2000;34:437-442.

Attachment 1: "Translation" And Analysis of a Paper Case by an Expert

Description of a 47 year-old woman with a nodular mass on her flank			
History	Past medical history	Family History	Social History
The patient first noticed a red plaque-like lesion on her left flank approximately 18 months ago. The lesion has never been tender or itchy. She has applied moisture lotion without improvement. Over the last 6 months, the lesion has become more raised and there was significant growth during the last 4 weeks. The patient denies any other health problems.	She underwent a hysterectomy in 1991 for multiple leiomyomas. Takes HRT and Tylenol as needed	The patient has three grown children, all alive and well. Her father is 70 years-old and suffers form atherosclerosis, and underwent a 3-vessel CABG at 58. Her mother died at the age of 40 from "womanly cancer".	Married 27 years, school librarian, no smoking, social drinker.



Expert categorical translation	
History	Physical Findings
• Persistent, progressive, nonpruitic, non-tender. • Location - lesions in trunk area not sun induced • Single lesion persistent progressive – Neoplasm • Past medical history not remarkable	• Poorly demarcated exophytic nodule • Color irregularity and border irregularity and satellitosis. • Lesions around the primary lesion usually indicate subcutaneous spread. • Some central infarction or necrosis.

Attachment 2: What Can We Learn From Examining Expert Schemas?

The first thing you might notice when you view the diagram is that the experienced dermatologist transformed the strictly descriptive information into key features or terms that were subsets of the larger implied categories of historical and clinical findings (see table below). Notice that the key features are comparative rather than purely descriptive and that they usually represent the absence or presence of a feature or the degree to which a feature exemplifies the category. Because of the concise nature of the transformed descriptors, the experienced clinician can combine a series of observed key features into principles or "rules" that can be used across settings and cases.

Developing "informal rules" based on the translated terms is much more efficient than trying to utilize the descriptive language provided. The combined "transformed" key features become "search terms" in the experienced clinicians' database of clinical and biomedical knowledge.

<table>
<tr><th>Description</th><th>Translation</th><th>Implied Category</th></tr>
<tr><td>The lesion had been present for 18 months</td><td>Persistent</td><td>Duration of symptom</td></tr>
<tr><td>Significant growth over the last four weeks</td><td>Progressive</td><td>Status of symptom</td></tr>
<tr><td>Lesion had never been tender</td><td>Painless</td><td>Pain/Sensation of symptom</td></tr>
<tr><td colspan="3">Expert generated "rule" – When a lesion is persistent, painless and progressive, it is rarely infectious and usually neoplastic.</td></tr>
</table>

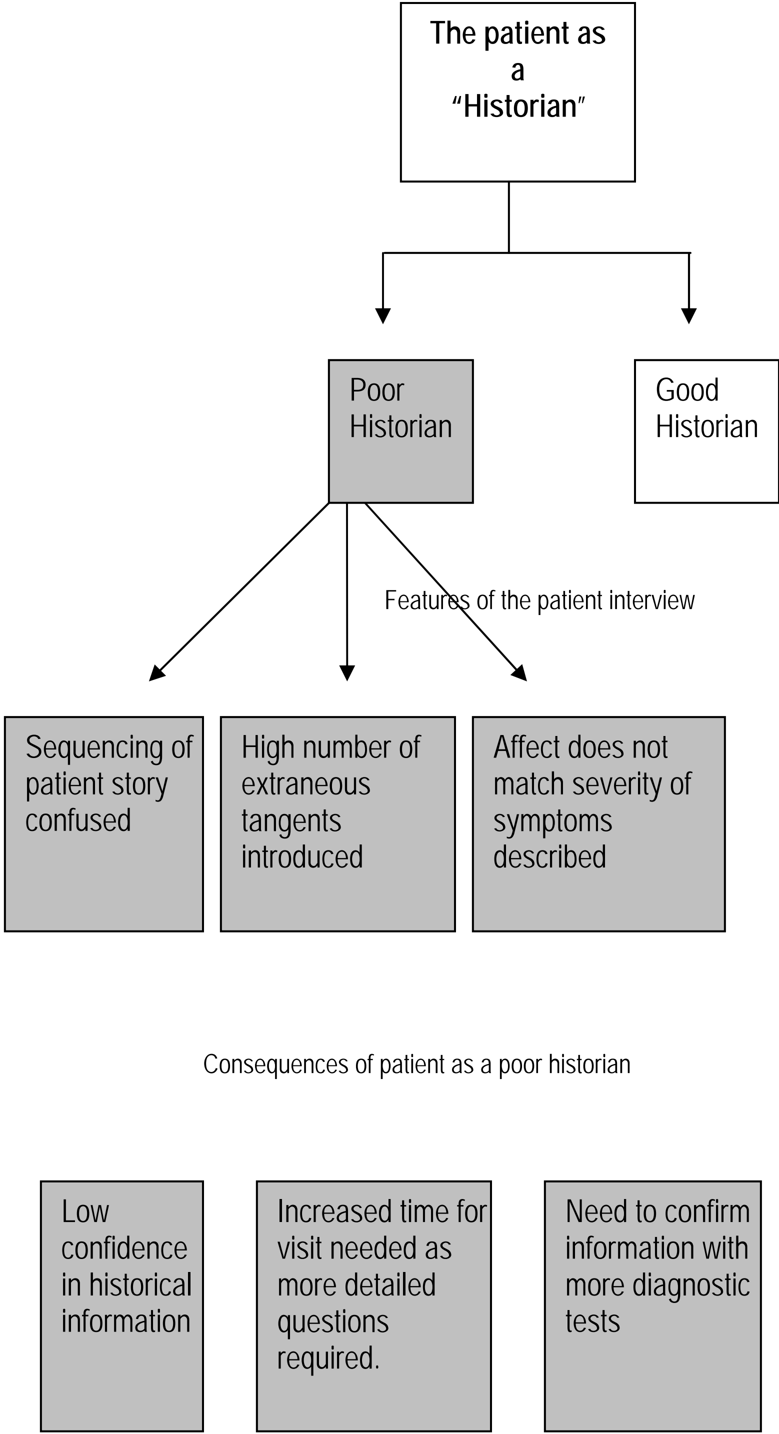
By being exposed to the schema of experienced clinicians, residents can

1. Learn to modify the language they use to describe their observations
2. Learn which categories of history questions yield the most pertinent information
3. Learn to develop or recognize "rules" as they exist in the observation of phenomena.
4. Apply new "rules" to a diverse set of cases in order to refine "rules" and recognize exceptions

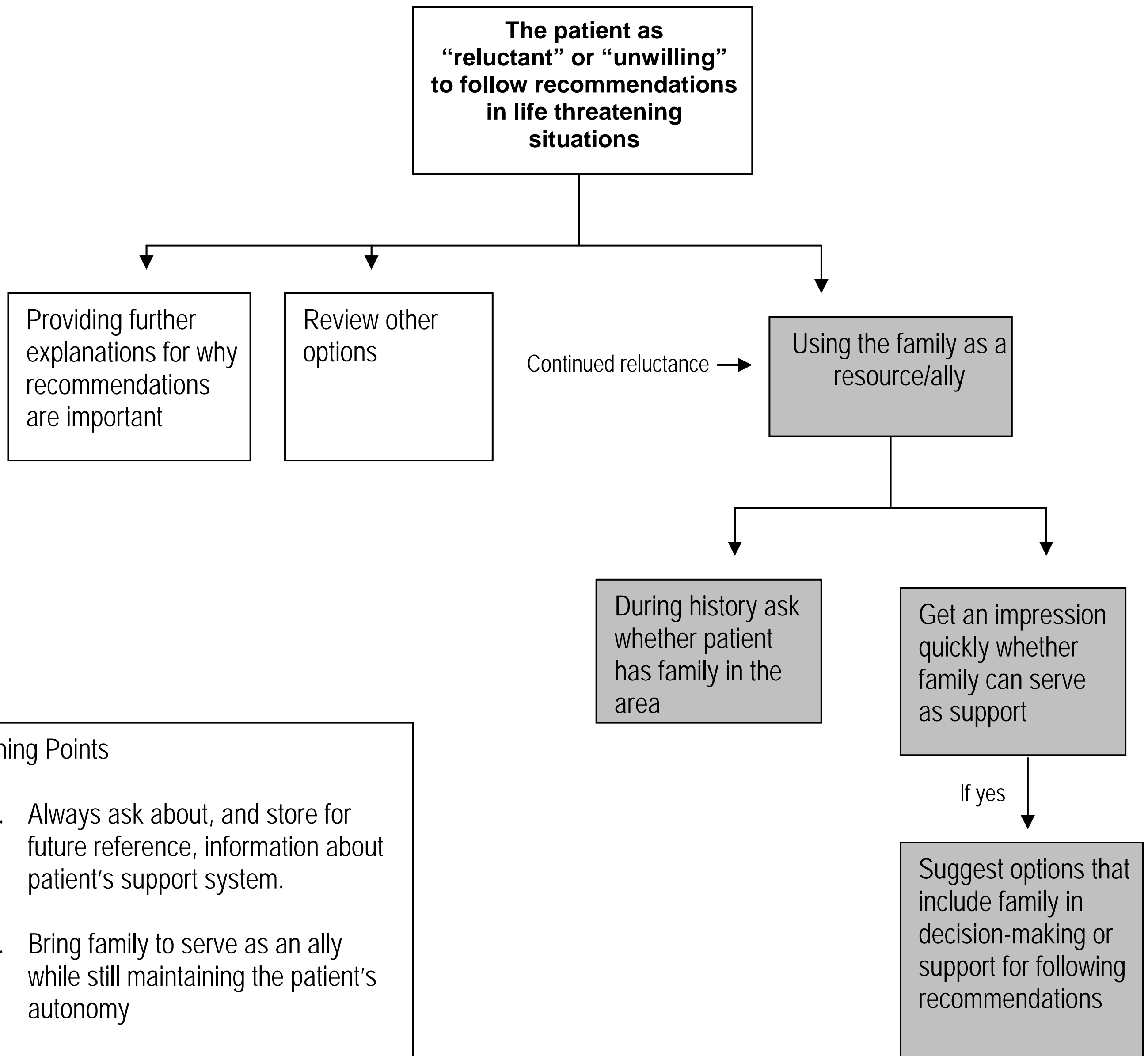
Attachment 3: Poor Historian

Teaching points

1. Recognizing the patient as a historian
2. Reflecting on the reasons why patients may present a confused history
3. Helping patients to become a good historian when possible
4. Timesaving strategies when dealing with “poor historians”
5. Dealing with frustration caused by interviewing “poor historians” in a busy practice



Attachment 4: Reluctant Patient



Teaching Points

1. Always ask about, and store for future reference, information about patient's support system.
2. Bring family to serve as an ally while still maintaining the patient's autonomy
3. Be willing to negotiate treatment plans based on the patient's best interest, needs and preferences.

Attachment 5: Generating schema-based diagrams (S-BD) or "re-creating clinical reasoning process"

Reading Case Model

1. S-BDs can be generated from reading unresolved real cases or from reviewing a paper case. When generating S-BD's from cases, think-aloud as you reason through the case. Remember to include all your thoughts, not just those referring to the diagnosis. Audiotape your reflections.

2. Review a transcript of the tape and mark points at which you have used language that suggests you have categorized the patient or situation. An example would be the use of the term "unilateral". By using this term, you have efficiently described the patient as belonging to a dichotomous category. Also, look for embedded capabilities, such as the ability to generate strategies for persuading a "reluctant patient" to follow recommendations.

3. If available, ask a member of the educational staff to view the same transcript and ask questions. This provides an additional educational perspective on the categories and capabilities identified.

4. Next, review the list generated and choose one or two capabilities or categories and create a diagram that elaborates on how to identify and use the categorical language or develop the capability.

Standardized or Real Patient Model

1. Obtain permission to videotape an encounter with a real patient or videotape an encounter with a standardized patient.

2. After the session, review the videotape stopping every few minutes to record what you were thinking at the time. (audiotape)

3. Ask a member of the educational staff or a colleague to view the videotape with you and ask clarifying questions and take notes. This provides an additional educational perspective on the categories and capabilities identified.

4. At the end of the session review the notes and the list generated and choose one or two capabilities or categories. Create a diagram that elaborates on how to identify and use the categorical language or develop the capability.