REVIEW

Enhancing the “What” and “Why” of the PPCP with the “How” of Clinical Reasoning

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Objectives. Clinical reasoning (CR) is integral to the provision of patient-centered care as outlined in the Pharmacists’ Patient Care Process (PPCP). However, the PPCP was not created to foster CR in student pharmacists and cannot be the sole tool used to characterize or cultivate these skills. This article seeks to describe elements of CR, the relationship between CR and PPCP, and concepts from the CR literature that should inform the teaching of CR skills.

Findings. Key elements of the PPCP were identified in CR definitions, but differences emerged. The literature supports CR as a bidirectional, fluid process that is highly collaborative. Effective CR requires multiple types of “thinking”, interaction with others and the environment, self-assessment, and a tolerance for nuance or ambiguity. Teaching strategies can be used in the didactic and experiential setting to target the cognitive and contextual factors associated with CR.

Summary. Educators should consult the CR literature to enhance our understanding of CR in seeking to teach, model, and foster these skills in our students. Future scholarship should include the development of models to support CR within the profession of pharmacy, adoption and experimentation with CR teaching techniques, and valuation of the utility of various assessment tools and processes.

Keywords: clinical reasoning, Pharmacists’ Patient Care Process (PPCP), cognition

INTRODUCTION

In order to develop student pharmacists who can provide patient care as described in the PPCP, pharmacy educators must teach and foster clinical reasoning (CR) skills. Despite its importance, there is limited consensus regarding the definition of clinical reasoning. Young et al. identified over 100 terms related to clinical reasoning in the literature.1 Psychological theories describe the “thinking” associated with CR.2 Frameworks in the health professions education literature characterize the action or skill-based functions of CR including collaboration, communication, creation of a management plan, and self-regulation of reasoning.2–7 Application of the PPCP requires many of the cognitive, behavioral, and action-based steps that are associated with CR. However, the PPCP was not created to foster CR in student pharmacists and cannot be the sole tool used to characterize or cultivate this skill. In order to teach, model, and foster these skills in our students, pharmacy educators should seek a deeper understanding of the components and processes involved in CR. This article seeks to describe elements of CR, the relationship between CR and PPCP, and concepts from the CR literature that should inform and enhance application of the PPCP. The paper also provides an overview of implications for teaching.

Clinical Reasoning and the Pharmacist

Most definitions of clinical reasoning begin with describing a mental process, using terms like “non-analytic” and “analytic”.3 Non-analytic processes are fast, instinct-like processes, such as intuitive knowing or pattern recognition. Analytic processes are more time-intensive and involve intentional investigation such as hypothesis testing or assessment of likelihood. Many definitions also identify specific practitioner behaviors, such as data collection,3,4,8 information synthesis,2,5,8 identification of patient preferences,8 or collaboration.5 Some definitions identify unique factors (ie, a practitioner’s reflection) that may impact these cognitive processes and behavior. Marcum proposes a cyclical model in which metacognition provides a link between non-analytic reasoning, analytic reasoning and clinical decision-making.4 Christensen also includes a metacognitive component noting “reflective” behavior. Christensen, Trowbridge, and Durning reference external factors, such as the context, setting or patient-specific factors, that influence CR.2,5,8 Interestingly, Christensen5 and Eva3 both use directional language such as “recursive, non-linear” and “proced[ing] in both directions”, respectively, to describe CR. Finally, many definitions name the outcome or goal of reasoning, such as identification of a diagnosis, therapy, or management plan.9,10 It is important to note that many definitions utilize
diagnostic-based language as much of the research and characterization of CR pertains to medical education. However, extrapolation to the profession of pharmacy is not only helpful, but necessary to enhance the CR skills of student pharmacists.

Many of the skills and behaviors described in CR definitions correspond with those attributed to critical thinking (CT), such as skills associated with interpretation, assessment, and evaluation of information. As with CR, CT is not well-defined in the literature due in part to the heterogeneous characterization of CT by various disciplines and the complexity of skills, actions, goals, and outcomes of CT. Both are context, setting and knowledge dependent. Additionally, both CT and CR require self-regulation and metacognitive skills for success. However, CR builds upon CT with its emphasis on integration of clinical evidence, previous experience, and collaboration with others. These additional skills and behaviors are unique to healthcare professionals because of the provision of patient-centered care. Thus, further elucidation of CR skills is valuable for the teaching and training of student pharmacists.

In order to describe the associations between CR and the work of the pharmacist, CR definitions were identified from the health professions education literature and health professions CR texts. The definitions in Table 1 were selected to represent the breadth of concepts articulated by health professions educators. Key elements of the PPCP were identified in each definition. The Collect phase was explicitly acknowledged in most definitions, recognizing that data collection allows the practitioner to obtain appropriate information to inform their thinking. All definitions also included elements of the Assess and either the Plan or Implement phases of the PPCP, emphasizing that cognition results in a behavior or action. However, only one definition included the Follow Up step. While Durning and Christensen explicitly identified the need for collaboration, the communication or documentation components were not included in any of the selected definitions.

In examining Table 1, it is clear that the PPCP incorporates some components of CR. In general, the PPCP framework includes the “what” and “why” of the pharmacist’s work, but not the “how” of CR during patient care. The PPCP does not describe the cognitive processes and behaviors necessary for the CR in application of Collect, Assess, Plan, Implement, and Follow up. Additional characteristics of CR that impact application of the PPCP are listed in Table 2. The PPCP’s circular, stepwise model suggests a linear direction. However, this process likely recurs repetitively and proceeds in both directions as student pharmacists reason. For example, when identifying and prioritizing medication therapy problems (MTP), student pharmacists must simultaneously collect and assess patient-specific information. Additionally, new information, unexpected events, or a change in a patient’s health-related goals may require a student pharmacist to move from the planning phase back to information collection prior to plan development and implementation. Thus, a student pharmacist who is reasoning clinically may move fluidly back and forth between multiple phases of the PPCP. Rigid adherence to the stepwise process of the PPCP may hinder effective CR.

Teaching Clinical Reasoning

The nuances identified in Table 2 have implications for teaching the PPCP and for fostering CR skills. Table 3 includes concepts from the CR literature that can inform discussion, modeling, and teaching of CR within the context of the PPCP. The CR literature supports use of multiple types of reasoning including analytical reasoning and the use of preliminary hypotheses in data collection and assessment. A student pharmacist should think critically about the information they are collecting and work to generate preliminary hypotheses about a patient’s MTPs. There is also a role for non-analytic reasoning as educators talk-aloud about the impact of their personal experience, intuition, and the recognition of patterns in the care of patients. Self-reflection and self-assessment of one’s own CR skills should occur frequently to promote self-awareness and to identify strengths, opportunities for learning, and personal biases. Student pharmacists must also acknowledge the impact of their environment and of others on CR as the reasoning process occurs. For example, a student pharmacist’s CR process would incorporate different variables when encountering a patient in a community pharmacy as compared to the emergency department. Finally, student pharmacists should discuss their reasoning with peers, educators, and practitioners. Dialogue and inquiry from others can enhance CR in the academic and clinical setting. This collaboration can be especially helpful when student pharmacists are working within the gray areas of patient care. As there may be more than one viable approach in the assessment and treatment of MTPs, student pharmacists must be comfortable using their CR skills to identify an appropriate course of action in a given context. The concepts identified in Table 2 and Table 3 are likely best understood when seen in action. Figure 1 provides an illustrative example of CR with important considerations highlighted.

Clinical reasoning is vital to wise action, professional autonomy, competence, and the capacity to reason during uncertainty and with ill-defined problems. Definitions, theories, models and frameworks can provide insight into the process of CR. They help to define CR, the variables involved, the interplay between the variables, and how the process “works”. However, no single theory seems to account for all aspects of CR. To better appreciate the complexities and evolution of CR in students, it can be helpful to consider CR as a threshold skill. A threshold skill is integrative (ie,
Considering utilizing cases or situations that slowly progress from simple to complex. Cases or situational activities can introduce students to the ambiguity, uncertainty, and complexity of clinical practice. Facilitate deliberate practice of these skills, and provide feedback regarding performance and competence. Real-world useful strategies (Table 4). These teaching strategies can help educators to highlight skills or steps associated with CR, reasoning over time, and in relation to junior colleagues. CR’s tight alignment with practice was also recognized. Supervised, repeated practice was reported as fundamental to developing their skills. Medical students also noted issues with transferability of CR skills, given that the reasoning was often specific to the situation and environment. As educators debate, design, and sequence the activities needed to support the development of CR abilities, it’s nature as integrative, troublesome, transformative and associated with practice, are important considerations. While learning to reason clinically is difficult, educators must also recognize the adjustment students are making to learn a different way. In the past, a student’s answers may have been prized and rewarded, along with their confidence in those answers. Yet, in CR the questions that they ask become important - questions of the patient, the situation, their peers, and themselves. CR is facilitated by the student’s curiosity, open-ended thinking, and dialogue with their clinical teachers. This process may reveal knowledge or skill deficits and induce feelings of vulnerability. Educators should encourage curiosity, questioning, and dialogue, while also being prepared to diagnose the student’s CR errors.

While cultivating CR skills in student pharmacists may seem like a daunting task, the CR literature proposes useful strategies (Table 4). These teaching strategies can help educators to highlight skills or steps associated with CR, facilitate deliberate practice of these skills, and provide feedback regarding performance and competence. Real-world cases or situational activities can introduce students to the ambiguity, uncertainty, and complexity of clinical practice. Consider utilizing cases or situations that slowly progress from simple to complex. This will allow student pharmacists to generate and integrate knowledge, practice cognitive processes related to CR, and develop experience. A specific strategy may be selected by considering learner level and learning activity. The serial-cue approach involves providing basic case information to the student and follow-up information only after students ask the appropriate questions or demonstrate a certain level of CR. The whole-case approach provides the entire case and associated information at the beginning of the simulation. CR scholars have hypothesized that lower-level learners or students with minimal CR experience may benefit from the serial-cue approach to promote script development and better question-seeking behaviors in these students.

Educators should watch for and verbally recognize signs that students' questions are changing from taught orrote questions to questions related to the problem or hypothesis. Educators should also watch for and interpret indirect signs related to the student’s CR, such as focused or unfocused patient interviewing and ability to identify discriminating features. Students and their teachers may benefit from adding clinical reasoning concepts into a familiar process such as the assessment of IESA (indication, effectiveness, safety, and adherence). Regardless of the approach used, teaching strategies should introduce students to and require use of different types of cognitive processes. In addition to these teaching strategies, educators should also model CR with students by discussing their CR and thought processes. For example, an educator could discuss the risk-benefit assessments of multiple evidence-based strategies (ie, gray areas or ambiguity), identify personal biases that may impact CR (ie, metacognitive factors), or describe how other members of the interdisciplinary care team may provide information imperative for the management of a specific MTP (ie, collaboration). Finally, educators can encourage students to practice deliberately and request feedback on their performance to maximize learning from each experience and allow for reflection on errors that occurred.

It is vital that CR be taught, practiced, and assessed in the didactic curriculum to prepare students for experiential education. Yet, there are currently no definitive best practices for teaching and assessment of CR. Assessments should include real-world cases and settings to align with situations students will see in practice. Assessments could utilize multiple “correct” pathways or answers based upon student’s reasoning. Additionally, as CR can be considered a threshold skill, CR could be included in progression assessments for each academic year or prior to APPEs. Both workplace-based assessments (eg, direct observations, global performance ratings) and non-workplace-based assessments (eg, multiple choice questions, essay-based questions) have been outlined.

As educators consider methods for addressing CR and situating it within curricula, the relationships between CR and various developmental processes and learning approaches should be considered. For example, for those interested in
implicit theories of ability (or “mindset”30,31), it could be useful to discuss and/or monitor a student’s mindset toward improving clinical reasoning. In addition, it may be helpful to aim instructional support at encouraging effort and maintaining a growth mindset through CR-related challenges. As another example, as students move through clinical reasoning thresholds and become more proficient, educators may observe CR’s influence on self-authorship32 (eg, trusting their internal voice) or elements of socialization and professional identity formation33 (eg, doubts of competence leading to anxiety, learning to live with ambiguity). Educators are encouraged to examine CR’s associations and intersections with familiar educational theories, concepts and approaches.

A Call to Action

The Accreditation Council for Pharmacy Education (ACPE) 2016 Standards require attention to CR and call for assessment of these skills throughout the curriculum.34 However, the Standards 2016 do not provide specific guidance to educators for addressing CR in the didactic or experiential setting. As educators train students to provide patient care through application of the PPCP, it is important to remember that the PPCP construct itself cannot be the sole tool used to define, teach, facilitate, and assess CR skills. Instead, educators should familiarize themselves with the cognitive processes, behaviors, and skills associated with CR, in order to teach and facilitate development of these capabilities. Knowledge generation and integration occurs as students practice the bidirectional and iterative process of CR and develop individual expertise. Viewing CR as a threshold skill for student pharmacists can promote intentional spacing and variety of CR activities, scaling of complexity, regular assessment and attempts at more articulate expectations for CR-related student performance. Cultivating these skills will ensure student pharmacists have the professional autonomy, competence, and ability to reason clinically within the real world context of ambiguity and uncertainty. Future scholarship should include the development of models to support CR within the profession of pharmacy, adaption and experimentation with CR teaching techniques and evaluation of the utility of various assessment tools and processes.

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Table 1. The Relationships between Clinical Reasoning and the PPCP

| Definitions and Descriptions of Clinical Reasoning | Collect | Assess | Plan | Implement*, Follow Upb |
|---------------------------------------------------|---------|--------|------|------------------------|
| Christensen, et al.: “Clinical reasoning (CR) is a nonlinear, recursive cognitive process in which the clinician synthesizes information collaboratively with the patient, caregivers, and the health care team in the context of the task and the setting. The clinician reflectively integrates information with previous knowledge and best available evidence in order to take deliberate action.” | Collect data, understand patient preferences | Synthesizes, integrates information with knowledge, evidence | Takes a deliberate action*, Recursiveb |
| Trowbridge, et al.: “We define CR as the cognitive and noncognitive process by which a healthcare professional consciously and unconsciously interacts with the patient and environment to collect and interpret patient data, weigh the benefits and risks of actions, and understand patient preferences to determine a working diagnostic and therapeutic management plan whose purpose is to improve a patient's well-being.” | | Interpret data, weigh benefits and risks | Working diagnostic, therapeutic management plan |
| McBee, et al: “…CR is a process ‘that enables practitioners to take wise action, meaning to take the best justified action in a specific context.’ …CR can be further divided into diagnostic reasoning and therapeutic reasoning. Diagnostic reasoning refers to how a clinician establishes a diagnosis, and therapeutic reasoning refers to how a clinician decides on a plan of action.” | | Establishes a diagnosis | Decides on a plan of action | Taking the best justified actiona |
| Durning, et al: “…CR encompasses both the mental processes as well as the behavior exhibited in terms of diagnostic and therapeutic decisions and that the mental processes and behavior are shared (or evolve) between the patient, physician, and environment. CR thus incorporates components of information processing, behaviorism, and situativity, respectively.” | History taking, physical exam, diagnostic tests | Mental processes, information processing | Diagnostic, therapeutic decisions | Behavior exhibitedb |
| Eva, et al: “…In this model, the clinician forms a mental representation of the case upon presentation of a patient and this mental representation leads to hypothesis testing, which in most cases will take the form of history taking, physical examination and the ordering of diagnostic tests. Importantly, the direction of reasoning is illustrated to proceed in both directions; results from hypothesis testing will influence the mental representation maintained by the clinician and the mental representation may have an influence on the way a patient’s problems are perceived.” | | | |
| Marcum: “CR begins with non-analytic processes in which the clinician assesses a patient’s presenting symptoms, as well as other clinical evidence, to arrive at a differential diagnosis from which he or she may make a clinical decision if a particular diagnosis fits the clinician’s previous experience. If no diagnosis fits that experience, then further clinical evidence is acquired and analyzed utilizing non-analytic processes to assess the differential diagnosis until a clinical decision is made diagnosing the patient’s illness and then how best to proceed therapeutically.” | Acquiring clinical evidence | Assesses symptoms, clinical evidence for fit; analytic, non-analytic processes | Diagnosis, therapeutic decision, how best to proceed |
Table 2. Enhancing PPCP Guidance Through Consultation of the Clinical Reasoning Literature

| Clinical reasoning is... | Commentary |
|-------------------------|------------|
| Bidirectional           | The PPCP’s unidirectional arrows imply linearity; however, the process is likely bidirectional. For example, pharmacists may generate hypotheses in their assessment of a patients’ MTPs and collect more information to test these hypotheses. |
| A non-linear process    | While all the steps in the PPCP should be performed in patient care, their order may not be lockstep or rigid. They may be recursive. For example, when discussing a plan, a pharmacist may find they need to go back and collect additional information. |
| Involving collaboration throughout the care process | The PPCP emphasizes collaboration in the plan step; however, CR requires collaboration throughout the care process. The pharmacist should seek input from other healthcare providers, patients, or caregivers at various steps in the PPCP to enhance the care process. |

CR: clinical reasoning  
MTP: medication therapy problem
| Clinical reasoning literature supports... | Description |
|------------------------------------------|-------------|
| **Cognitive Processes**                 |             |
| Using preliminary hypotheses            | Multiple frameworks identify problem representation and hypothesis generation as important components in CR.\(^5,6,7\) Student pharmacists identify and characterize potential medication therapy problems (MTP) and can be encouraged to generate hypotheses regarding possible causes and appropriate treatments. |
| Recognizing multiple types of thinking or reasoning | CR includes cognitive processes that are both non-analytic (ie, intuition, pattern recognition) and analytic (ie, detailed analysis, hypothesis testing). Student pharmacists may be more likely to engage in analytic reasoning, while more experienced practitioners may rely more heavily on experience and non-analytic thinking. Both types of reasoning can be discussed, modeled, and practiced.\(^21,24\) |
| Attending to metacognition               | Pursuing a practice of ‘mindfulness’ as described by Epstein will foster self-reflection, self-awareness, and regulation of one’s own analytic and non-analytic reasoning skills.\(^4,18\) |
| **Contextual Variables**                |             |
| Being aware of the pharmacist-specific attributes | Appropriate assessment depends on integration of clinical knowledge, skills, and experience.\(^5\) Students can be prompted to identify and remediate knowledge or experience deficits that may influence CR. Well-being, motivation, and personal biases should also be considered. |
| Understanding the importance of environment and situation | CR is thinking and action in context.\(^2,5,8,10\) Situational and environmental factors such as the practice setting, institutional policies, and duration of patient encounter will impact CR and the patient care process. |
| Working within gray areas               | CR acknowledges the role of ambiguity and nuance.\(^2,19\) While the PPCP describes the creation of an evidence-based plan, clinical evidence may be lacking or patient-specific factors may dictate selection of a less evidence-based strategy. In these situations, student pharmacists should assess the risks and benefits of treatment options\(^8\) and make the best patient-centered choice in each context.\(^10\) |
| Acknowledging CR as a social process    | CR is commonly perceived as an individual intellectual endeavor. However, CR is supported by input, questioning, and collaborative dialogue with others.\(^17\) Collaboration with other members of the healthcare team, the patient, caregivers, and other stakeholders is vital for CR.\(^5,17\) |

CR: clinical reasoning
| Teaching Challenge | Selected Teaching Strategies |
|--------------------|-----------------------------|
| **Cognitive Processes** | |
| Using preliminary hypotheses | Encourage *active information seeking* to assist learners in minimizing omission errors. Educators should stress *early hypothesis generation* with active confirmation or rejection strategies. In addition, prompt learners to articulate their reasoning. Student pharmacists can verbally identify hypotheses, clarifying questions asked, and information that led to rejection or retention of the hypothesis. |
| Utilizing multiple types of thinking or reasoning | Describe when *analytical reasoning versus non-analytical reasoning* may be helpful. Teach non-analytic reasoning (e.g., checklist approach, use of scripts, flexibility, and cross-check) in order to ensure errors or information is not overlooked. Prompt for *pattern recognition* to help students identify common and uncommon situations or cases. The educator’s role is to facilitate development of links between features (e.g., sign and symptoms, key features) to categories (e.g., MTP). Pattern recognition develops over time with more experience. |
| Attention to metacognition | Raise *self-awareness* of CR. Students may lack ability to assess their own CR abilities. Educators should monitor for students’ self-assessment skills, especially in regard to overconfidence, which can lead to errors. Students can be prompted to identify and examine their own mistakes. |
| **Contextual Variables** | |
| Acknowledging practitioner variables | Acknowledge the potential effects of *practitioner variables* (e.g., motivation, emotion, sleepiness, well-being) through examples and assessments. |
| Working with gray areas | Explicitly compare problem possibilities. Epidemiology and local variation may help to compare and contrast potential presentations, treatment options, and outcomes. Educators can provide commentary regarding distinguishing features of diagnostic or MTP possibilities. *Pose risk-benefit assessments* including factors such as health, finances, and quality of life. In addition, focus on problem prioritization instead of the identification of a single correct answer. Encourage student pharmacists to *commit to one “final” decision (even if it is incorrect)* to mimic real-world experience and develop strength and resolve when grappling with difficult choices. |
| Acknowledging CR as a social process | Encourage students to *share observations aloud with others* (e.g., faculty, healthcare professionals, or students). Discuss the shared and evolving nature of problem-identification and decision making, considering the interactions between the patient, provider and environment. |
| Understanding the impact of environment and situation | *Local practices* (e.g., formulary) may influence treatment options. Recent cases may impact current thought and opinion. Educators should create diverse cases with regard to practice setting, acuity, institutional policies, healthcare team involvement, and patient engagement. |

**CR**: clinical reasoning  
**MTP**: medication therapy problem
Figure 1. Illustrative Example of Clinical Reasoning through Application of the PPCP

Using preliminary hypothesis: Martin develops an initial hypothesis, and then an alternative hypothesis

Bidirectional: Martin moves back and forth between collecting and assessing

Involving collaboration throughout the care process: Martin collaborates with nurse to collect information

Attending to metacognition: Jasmine reflects on her own skills.

Understanding the importance of environment and situation: Jasmine’s collaborative practice agreement influences her.

Acknowledging CR as a social process: The PCP and Jasmine have collaborative dialogue about symptoms.

A non-linear process: Jasmine moves straight from implement back to collect (bypasses follow up).

Recognizing multiple types of thinking or reasoning: Martin uses his analytic perspective from looking at statistics and Jasmine highlights her non-analytic experience.

Working within gray areas: Martin weighs two potential MTPs and decides how to proceed.

Being aware of the pharmacist-specific attributes: Jasmine uses past experience.

Legend:
Boxes with shading include concepts from Table 2. Boxes without shading include concepts from Table 3.
| Clinical reasoning literature supports... | Description |
|------------------------------------------|--------------|
| **Cognitive Processes**                  |              |
| Using preliminary hypotheses            | Multiple frameworks identify problem representation and hypothesis generation as important components in CR. Student pharmacists identify and characterize potential medication therapy problems (MTP) and can be encouraged to generate hypotheses regarding possible causes and appropriate treatments. |
| Recognizing multiple types of thinking or reasoning | CR includes cognitive processes that are both non-analytic (i.e. intuition, pattern recognition) and analytic (i.e. detailed analysis, hypothesis testing). Student pharmacists may be more likely to engage in analytic reasoning, while more experienced practitioners may rely more heavily on experience and non-analytic thinking. Both types of reasoning can be discussed, modeled, and practiced. |
| Attending to metacognition              | Pursuing a practice of 'mindfulness' as described by Epstein will foster self-reflection, self-awareness, and regulation of one's own analytic and non-analytic reasoning skills. |
| **Contextual Variables**                |              |
| Being aware of the pharmacist-specific attributes | Appropriate assessment depends on integration of clinical knowledge, skills, and experience. Students can be prompted to identify and remediate knowledge or experience deficits that may influence CR. Well-being, motivation, and personal biases should also be considered. |
| Understanding the importance of environment and situation | CR is thinking and action in context. Situational and environmental factors such as the practice setting, institutional policies, and duration of patient encounter will impact CR and the patient care process. |
| Working within gray areas               | CR acknowledges the role of ambiguity and nuance. While the PPCP describes the creation of an evidence-based plan, clinical evidence may be lacking or patient-specific factors may dictate selection of a less evidence-based strategy. In these situations, student pharmacists should assess the risks and benefits of treatment options and make the best patient-centered choice in each context. |
| Acknowledging CR as a social process    | CR is commonly perceived as an individual intellectual endeavor. However, CR is supported by input, questioning, and collaborative dialogue with others. Collaboration with other members of the healthcare team, the patient, caregivers, and other stakeholders is vital for CR. |

CR: clinical reasoning
Table 4: Suggestions for Addressing Challenges in Teaching Clinical Reasoning

| Teaching Challenge                             | Selected Teaching Strategies                                                                 |
|-----------------------------------------------|----------------------------------------------------------------------------------------------|
| Cognitive Processes                           |                                                                                               |
| Using preliminary hypotheses                  | Encourage *active information seeking* to assist learners in minimizing omission errors.\(^{21}\) Educators should stress *early hypothesis generation* with active confirmation or rejection strategies.\(^{24}\) In addition, prompt learners to articulate their reasoning.\(^{26}\) Student pharmacists can verbally identify hypotheses, clarifying questions asked, and information that led to rejection or retention of the hypothesis. |
| Utilizing multiple types of thinking or reasoning | Describe when *analytical reasoning versus non-analytical reasoning* may be helpful.\(^{3}\) Teach non-analytic reasoning (e.g., checklist approach, use of scripts, flexibility, and cross-check) in order to ensure errors or information is not overlooked.\(^{20,21,23}\) Prompt for *pattern recognition* to help students identify common and uncommon situations or cases. The educator’s role is to facilitate development of links between features (e.g., sign and symptoms, key features) to categories (e.g., MTP) Pattern recognition develops over time with more experience.\(^{3,23}\) |
| Attention to metacognition                     | Raise *self-awareness* of CR.\(^{23,24}\) Students may lack ability to assess their own CR abilities. Educators should monitor for students’ self-assessment skills, especially in regard to overconfidence, which can lead to errors. Students can be prompted to identify and examine their own mistakes. |
| Contextual Variables                           |                                                                                               |
| Acknowledging practitioner variables           | Acknowledge the potential effects of *practitioner variables* (e.g., motivation, emotion, sleepiness, well-being) through examples and assessments.\(^{2}\) |
| Working with gray areas                        | Explicitly *compare problem possibilities*.\(^{21}\) Epidemiology and local variation may help to compare and contrast potential presentations, treatment options, and outcomes. Educators can provide commentary regarding distinguishing features of diagnostic or MTP possibilities.  

*Pose risk-benefit assessments* including factors such as health, finances, and quality of life. In addition, focus on problem prioritization instead of the identification of a single correct answer.\(^{22}\)  
Encourage student pharmacists to *commit to one “final” decision* (even if it is incorrect)\(^{21}\) to mimic real-world experience and develop strength and resolve when grappling with difficult choices. |
| Acknowledging CR as a social process           | Encourage students to *share observations aloud with others* (e.g. faculty, healthcare professionals, or students).\(^{23}\) Discuss the shared and evolving nature of problem-identification and decision making, considering the interactions between the patient, provider and environment.\(^{3}\) |
| Understanding the impact of environment and situation | *Local practices* (e.g., formulary) may influence treatment options. Recent cases may impact current thought and opinion.\(^{3}\) Educators should create diverse cases with regard to practice setting, acuity, institutional policies, healthcare team involvement, and patient engagement.\(^{2,3}\) |

CR: clinical reasoning  
MTP: medication therapy problem