Learning processes in Bedside Teaching that Foster Clinical Reasoning in Students:

A Qualitative Study

BY

TARA JAFFERY
MD. University of Illinois at Chicago, 1997.

THESIS

Submitted as partial fulfillment of the requirements for the degree of
Masters in Health Professions Education in the Graduate College of
the University of Illinois at Chicago, 2017.

Chicago, Illinois.

Defense Committee:

Ilene Harris, Chair and Advisor
Ara Tekian, DME
Alan Schwartz, DME

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

SUMMARY

We explored the learning processes that take place during inpatient bedside teaching (BST) that help students develop Clinical Reasoning (CR) skills. CR refers to the cognitive processes required by clinicians to diagnose and manage patients' medical problems. Workplace based patient encounters, followed by discussions with clinicians were used to explore the learning processes that facilitate CR in the patient encounter of fifth-year (final year) medical students during BST in medicine, surgery, pediatrics and obstetrics, and gynecology clerkships.

Learning processes were identified using Stimulated Recall method. The data were analyzed using qualitative methods of constant comparative analysis, associated with the grounded theory approach. We identified several themes in our analysis which represented learning processes recalled during CR instances in BST. Application of students' prior knowledge to patient care, discussion of clinical concepts in the context of the patient's case, and giving justification for responses during the discussion were the most frequent themes. The themes showed that the processes of problem representation and evaluation repeatedly occur during CR and also highlighted the contextual nature of CR. The learning processes related to CR were identified at all stages of the student-patient encounter: while doing the history and physical examination, formulating a differential diagnosis, and developing management plans for the patient. The themes were independent of disciplines.

CR processes start very early in the student-patient interaction and continue in all subsequent stages of the encounter. The problem representation-evaluation cycle is at the core of the CR process and strategies to promote this process are crucial to facilitate learning of CR.

I. INTRODUCTION

1. Background:

Clinical reasoning is a core competency for medical practice, which is essential for the formulation of diagnoses and safe and efficient management of patients. Clinical Reasoning (CR) refers to the cognitive processes used by clinicians to diagnose and manage patients' medical problems. It is described as an "idiosyncratic, multifaceted and highly complex skill, characterized by different processes that mobilize specific knowledge held in long-term memory" (Pelaccia et al, 2011).

The diagnostic and therapeutic tasks which are the focus of CR are complex, practical problems which characterize the real life practice of medicine (Gruppen & Frohna, 2012). Work-based discussions of patient encounters in both inpatient and outpatient settings are one of the most relevant educational experiences that contribute to development and enhancement of clinical reasoning skills (Kassirer, 2010; Pelaccia et al, 2011). Formal bedside teaching round discussions, which focus on various aspects of patient care in the context of real patient encounters, have traditionally been a central component of the inpatient setting (Abdool & Bradley, 2013). Studies have shown that teaching rounds, which include interactions with patients, are preferred by both educators and learners for clinical learning (Nair et al., 1997; Nair et al, 1998). Learners acknowledge the importance of bedside teaching for learning essential clinical skills (Williams et al, 2008). In a formal bedside teaching program in an emergency medicine department, clinical reasoning was perceived to be the most important thing learned (Celenza & Rogers, 2006). In this study, we will refer to the formal bedside teaching round as BST. Many studies have shown the importance of BST, and proposed strategies to improve bedside clinical teaching. (LaCombe, 1997; Abdool & Bradley, 2013; Ende, 1997; Spencer, 2003; Gonzalo et al, 2013; Irby, 1994). Teaching clinical reasoning skills is a difficult challenge, and a better understanding of the cognitive processes involved in

the learning of CR can contribute to more effective teaching for the development of clinical reasoning competencies in learners (Cutrer et al, 2013).

We used the model for clinical reasoning proposed by Gruppen and Frohna (Gruppen & Frohna, 2012) and Cognitive Theories of Learning as conceptual frameworks to guide our inquiry related to learning processes in BST and recommendations for development of CR skills in medical students.

2. Purpose of the study:

Cognitive processes during CR in BST recalled by SR procedure can help to understand the learning processes that facilitate development of CR skills in students during BST.

The purpose of this study was to explore the learning processes that take place during the BST that help students develop CR skills. We applied a naturalistic study design, using case discussions during bedside teaching on real patients in the inpatient setting (BST). We used the Stimulated Recall method, with audiotapes of the bedside teaching sessions, to stimulate students and the teacher to recall their cognitive processes during instances of CR by students during the BST session. We asked participants to recall the incidences of CR and provide an oral account of their thought processes at the time (Calderhead, 1981). We analyzed their response using qualitative methods to explore teaching/learning processes which help students develop CR in BST using the integrative model of clinical reasoning by Gruppen and Frohna and cognitive theories of learning as our conceptual framework.

II. CONCEPTUAL FRAMEWORKS AND RELATED LITERATURE

1. Gruppen and Frohna's integrative model of the Clinical Reasoning process:

Clinical reasoning research shows a diversity of theoretical viewpoints to define cognitive processes. Gruppen and Frohna's model of the Clinical Reasoning process (Gruppen & Frohna, 2012) incorporates the fundamental elements of several theoretical frameworks and characterizes CR as an iterative process that integrates learners' knowledge structures, situational problem representations, context and emotional and social components (Figure 1).

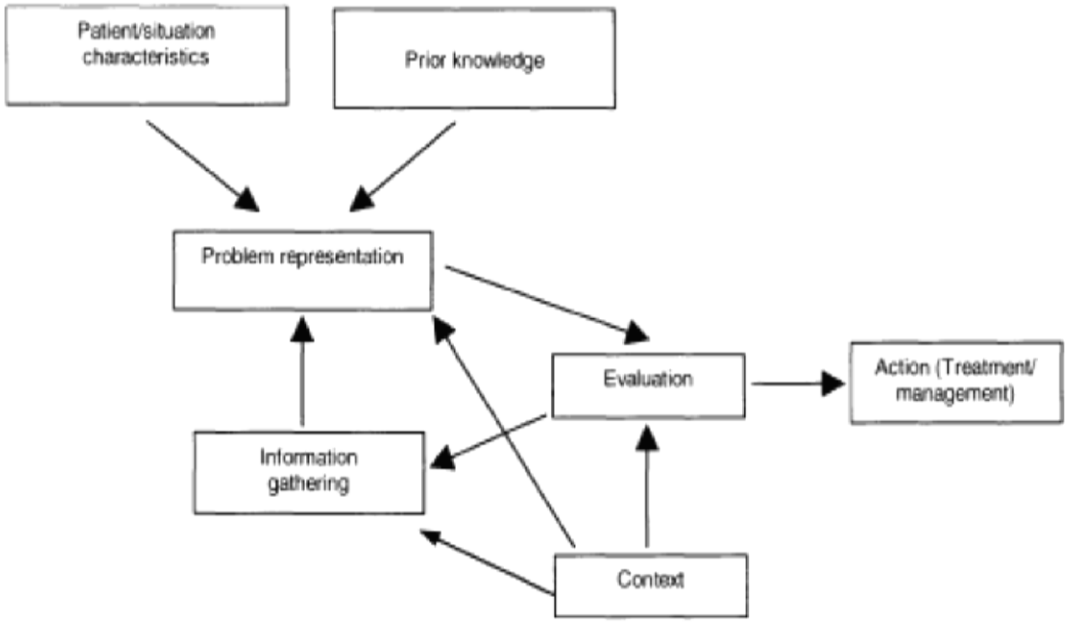

Figure 1. A model of the clinical reasoning process

Note. From: *International Handbook of Research in Medical Education* (p. 206), by Larry D. Gruppen and Alice Z. Frohna, 2002, Kluwer Academic Publishers. © 2002 Springer Science+Business Media Dordrecht. Reproduced with permission of Springer Science+Business Media Dordrecht.

In this model, the reasoning process starts by integration of the information from the patient with the physician's previous knowledge, i.e., the stable knowledge structures stored in schemas to form an

initial "problem representation." This initial temporary cognitive structure is generated very early in the patient encounter (Elstein et al, 1979) and is evaluated for completeness and fit with the available information. The evaluation process is ongoing and guides additional information gathering and evaluation until a satisfactory "fit" is attained, and the cycle is stopped for the practitioner to proceed to action (Charlin et al, 2000). This evaluation is unconscious and automatic in the initial phases, and with simple problems, or conscious and mindful as the problem representations, become more refined and for complex problems (Elstein & Schwartz, 2002; Eva, 2005). The problem-solving ability of experts and novices differs due to the relative sophistication of these problem schemas and the rich and elaborate network of connections developed to access these schemata in experts. Another critical component of this CR model is that it accounts for the influence of context in problem representation, evaluation, and information gathering. Context includes factors such as the social context of the problem and the affect and motivation of the learners (Gruppen & Frohna, 2012).

2. Cognitive theories of learning:

The physician's prior knowledge plays a key role in the CR process, also demonstrated in our selected CR model. Understanding how knowledge is represented in memory and retrieved to solve new problems is the basis of cognitive learning theories and important for understanding learning at a cognitive level.

Rumelhart and Norman proposed three qualitatively different mechanisms of learning within the schema-based theory of long-term memory (Rumelhart & Norman, 1976; Rumelhart & Norman, 1981). A schema is an abstract knowledge structure that encompasses likenesses between two or more examples of typically complex concepts, and help a person to categorize new experiences, objects or events rapidly through accretion, tuning, and reconstruction (Custers & Boshuizen, 2002). Accretion is

responsible for learning most of our new knowledge by matching new information with the previously available schemata and also results in integration of new knowledge within the concepts contained in an existing schema. Restructuring occurs when new perspectives do not fit the current schemata, or the organization of the existing schemata is inadequate. This restructuring can occur using schema induction or pattern generation. Complex new processes are created by modeling them in relation to existing schemata and modifying them slightly. The characteristics of the source schema that do not fit provide the basis for generation of a new schema. The similarities between the two are carried over to the new schema, even though this may not be perceptible in the initial learning situation. These similarities are what allow learners to make inferences about the new situation without explicit knowledge of the new situation (Rumelhart & Norman, 1981). Tuning refers to the gradual and deliberate modification of existing schemata for practical use of knowledge. Tuning can improve the accuracy of identifying concepts better through processes such as like generalizability or discrimination. New knowledge is added in the form of examples, details, images, extensions, and interpretations which help to provide alternative recovery pathways to access information stored in the memory and construction of meaning and reconstruction of forgotten knowledge by connecting new knowledge to existing knowledge (Harris, 2011). Knowledge is organized along semantic axes, for example, acute-chronic and monoarthritis-polyarthritis (Steward et al, 1991). These axes provide an organizational framework to distinguish and relate alternative disease representation. This process of elaboration is improved if the significance of target concepts is concise and clear, which facilitates retrieval and use of these concepts to solve new problems (Custers & Boshuizen, 2012). These usable clinical memory structures are tuned and refined through use and clinical practice. Memory structures are individually developed, and the organization and accessibility of memorized knowledge differ from person to person. Therefore they will think differently when exposed to the same set of information (Grant & Marsden, 1988).

Clinical information is recognized and interpreted by recognizing certain key features from previously encountered clinical experience. These key points or “forceful features” are personally identified information which subsequently triggers retrieval of clinical information (Grant & Marsden, 1987).

3. Stimulated Recall Procedure:

It is difficult to explore cognitive processes during learning. We often rely on the learners' accounts of their thought process during the event. Several approaches are available in the literature for this purpose, such as Process Training and Stimulated Recall. Process training procedures, such as think-aloud techniques, use concurrent verbalization of thoughts during experimental problem-solving. These approaches are inefficient in accessing cognitive processes and even have a negative impact in real life problem-solving circumstances (Hoffman et al,1995; Dickson et al, 2000). The Stimulated Recall (SR) method is an indirect method of obtaining evidence of cognitive activity, which is inferred from the subject’s oral account (Lyle, 2003). SR is an introspective research method in which study subjects recall concurrent thought processes during the event when triggered by viewing videotaped passages of behavior to stimulate recall of their concurrent cognitive activity (Lyle, 2003). SR methods have been utilized widely in educational research in teaching, nursing, and counseling (Kagan et al, 1963; Gale & Marsden, 1982).

There are several potential limitations in using SR methods. The subject may supplement incomplete memories during the recall and introduce secondary ordering and bias in cognition by added reflections during SR (Yinger, 1986). The SR method may induce anxiety and stress, from fear of inadequacy. There is recall decay with time, and direct prompts and questioning regarding actions can introduce researcher bias and lead to the subject forming explanations to defend intentions (Gass & Mackey, 2000). However,

a series of steps have been proposed to increase the reliability and validity of data collected by SR methods, and the SR method is considered to be a valuable method to obtain indirect evidence of cognitive activity despite its limitations (Gass & Mackey, 2000).

III. STUDY METHODOLOGY

1. Overview of study research methods:

The research aims of the study were to:

Explore the teaching/learning processes that facilitate development of CR skills of medical students in BST, and

We obtained IRB approval from the University of Illinois, Chicago and the Shifa Tameer-e-Millat University, Islamabad, Pakistan. The study subjects were medical students who were in their fifth (final) year of medical school at Shifa College of Medicine, rotating in their clinical clerkships.

An operational definition of CR was developed, based on literature review, as “instances when students provide reasoning regarding their proposed diagnoses, explain patients’ presentations and physical examination or laboratory findings, or formulate management plans regarding patients' medical problems."

We used a naturalistic study design to explore the learning processes that help students develop CR skills during the regular inpatient bedside teaching rounds (BST) of fifth-year medical students with their clinical teachers in the Medicine, Surgery, Pediatrics and Obstetrics and Gynecology clerkships. We audio-recorded the BST discussion with students. The audio-recordings of the teaching cases were used for stimulated recall of learning processes during the CR process, in focus group discussions (FGD) with students and separate one-on-one interviews with participating faculty.

During the BST, students present the clinical information such as history and examination of a real patient they have seen in the inpatient setting, and a discussion ensues at the bedside between the clinical teacher and the students regarding the clinical presentation, diagnosis, and management of the

patient. We audio-recorded this BST discussion and used it to help students and teachers to recall their cognitive processes during instances of CR by students during the BST session in focus group discussions (FGD) with students and separate one-on-one interviews with participating faculty. We chose FGD for students because the BST was a group discussion; however, each instance of CR involved an individual student, and only that particular student was asked to recall his/her thought process at the time. We focused on both the students and the teacher participating in the BST because our goal was to explore teaching/learning processes which may have helped students with the CR process during the BST session. We asked participants to recall the incidences of CR and provide an oral account of their thought processes at the time. The FGD of students and faculty interviews were audio-recorded and transcribed. The transcriptions were analyzed using qualitative methods to determine teaching/learning processes which help students develop CR skills in BST.

2. Data Collection process:

Forty-eight (48) fifth-year medical students and nine clinical faculty members participated in the study. A total of nine BST discussions were audio-recorded, three sessions each for the clerkships of Medicine and General Surgery, two for Obstetrics and Gynecology and one for Pediatrics clerkship, each one followed by a faculty interview and a FGD with students. Eighteen (18) transcriptions from the faculty interview and student FGD were analyzed.

We obtained consent from participating students and faculty at the beginning of the clinical clerkships after outlining the study purpose. The consent included an agreement for audio-recording BST and focus group or faculty interview on the same day as the BST, usually within one hour of the BST. The selection of the clinical encounter to be recorded depended on the availability of the students and

faculty member for the FGD and interview right after the BST. The students and faculty were informed of the venue of the FGD or interview before the audio-recording. The plan to record the teaching session was discussed with the faculty before the session, and the patient to be discussed was informed, and verbal consent for audio recording was obtained before the session. The audio-recordings were initiated by the faculty conducting the teaching round; the investigators did not observe the BST.

After the BST in each specialty was audio-recorded, we conducted a one-on-one interview with the faculty member facilitating the BST and a focus group discussion with the students participating in the BST, within one hour of the BST, to explore learning processes in clinical reasoning during BST. The audio-recordings were used for stimulated recall by the faculty and students. We took additional steps in our study to avoid potential limitations of the stimulated recall method. The purposes and process of stimulated recall technique were explained to the faculty and students, without stressing the actual purpose of the study, to reduce researcher influence on participants' responses. We provided a non-threatening environment for stimulated retrospection, with separate sessions for faculty and students, to avoid participant anxiety. All SR sessions were conducted within one hour of the bedside teaching session, to reduce potential memory decay with time delay (Lyle, 2003; Calderhead, 1981). Open-ended or "non-directed" questions, which support recall about the bedside teaching session, but which limit the perceptions by students and faculty of judgmental probing and intrusion into the process, were used as prompts for the focus groups and interviews (Calderhead, 1981; Gass & Mackey, 2000).

We explained our operational definition of CR to the participants at the start of the interview/FGD. During the FGD with students, the facilitators (AR, AT, SI) and the students identified instances of CR, based on our operational definition of CR, by listening to the BST audio-recording. The audio-recording was stopped each time anyone identified a CR example, the student connected to that particular instance identified himself/herself. The facilitator asked the student involved to recall his/her

concurrent thought processes during the CR incidence which lead to his/her response. The facilitator encouraged students to recall their thinking processes by non-leading prompts such as “do you recall what made you give that particular response at the time?” The facilitator avoided probing questions and did not ask for any explanations regarding the students’ responses.

During the one on one interview, the facilitators (AR, AT, SI) and the teacher identified instances of CR, during the BST, based on our operational definition of CR, by listening to the BST audio-recording. The audio-recording was stopped each time anyone identified a CR example. The facilitator encouraged the teacher to recall his/her concurrent thinking processes by prompts such as “Do you recall what you were thinking when you asked this question, made this comment or the student’s response?” The facilitator avoided any probing questions asking for justification or explanations regarding the teacher’s approach to teaching/learning.

The faculty interview and student focus group discussion of all BST were audio-recorded and transcribed by a trained transcriber. All personal identifiers were deleted from the transcriptions. The participants’ responses represent indirect evidence of cognitive processes during CR in BST. Content analysis of the participants’ responses was done using the inductive approach of constant comparative analysis associated with grounded theory research design (Corbin & Strauss, 1990) to determine learning processes which aided students in CR during BST.

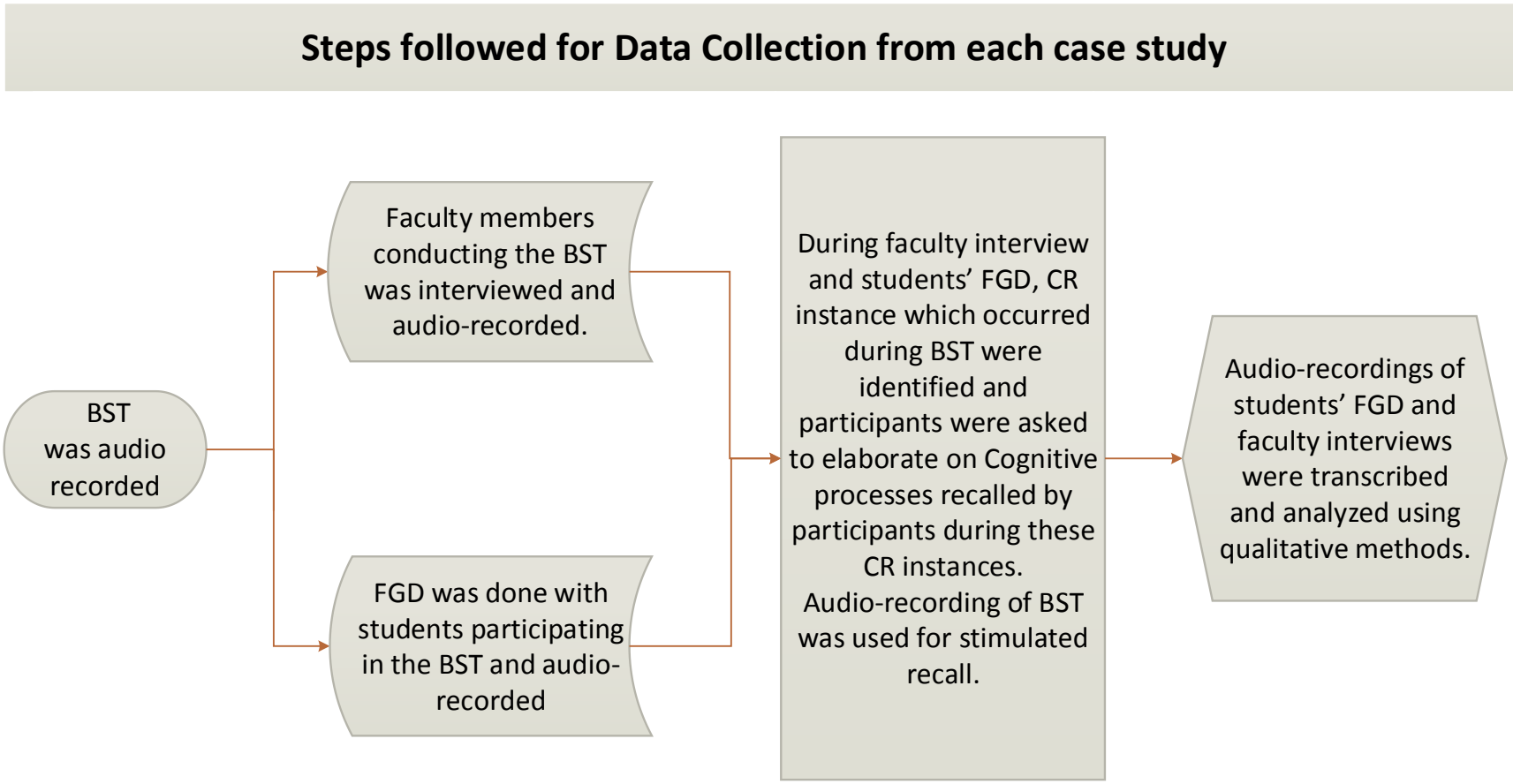

Figure II. BST: Bedside teaching session CR: Clinical reasoning FGD: Focus group discussion

3. Data Analysis process:

As the first step in data analysis, the PI (TJ) reviewed all the transcriptions for accuracy using the audio-recordings. This immersion in the data serves to identify themes within their clinical context (Crabtree & Miller, 1999; Pope et al, 2000). TJ did the initial coding by the transcribed students' FGD, and faculty interviews line by line, starting with one case discussion from each specialty and reviewing the FGD and interview of each case concurrently as a way to triangulate the responses, i.e., perspective triangulation (Patton, 1999). During the initial coding, every instance of CR and the recall of the students and faculty were highlighted, and as concepts became apparent, codes were assigned. The concepts were tested for trustworthiness and refined by comparing the concepts with new data from the FGD/interviews of case discussions which provided for the codes to evolve inductively and reflect the experiences of the participants. Similar concepts were grouped together under representative themes which denote the learning processes for CR, generating the initial thematic structure. Theme saturation was reached by the fifth case as no further themes were identified.

The remaining four cases were then analyzed independently by a co-investigator (NS), using the initial thematic structure developed by TJ and there was a general agreement about the themes. We resolved differences by discussion and clarification in which all the study investigators participated and developed the final thematic structure. We asked two of the participating faculty, and seven students, to determine if the final themes/ subthemes were representative of their recalled responses (member check). The principal investigator (TJ) then analyzed the transcripts using the final thematic structure, identified the number of responses for the themes/subthemes in the data set and chose representative quotes for illustration of the themes. In our study, we obtained the perspectives of both students and teaching faculty regarding CR processes for triangulating data sources (Patton, 1999) and also used various facilitators for the FGD and interviews (AR, AT, SI).

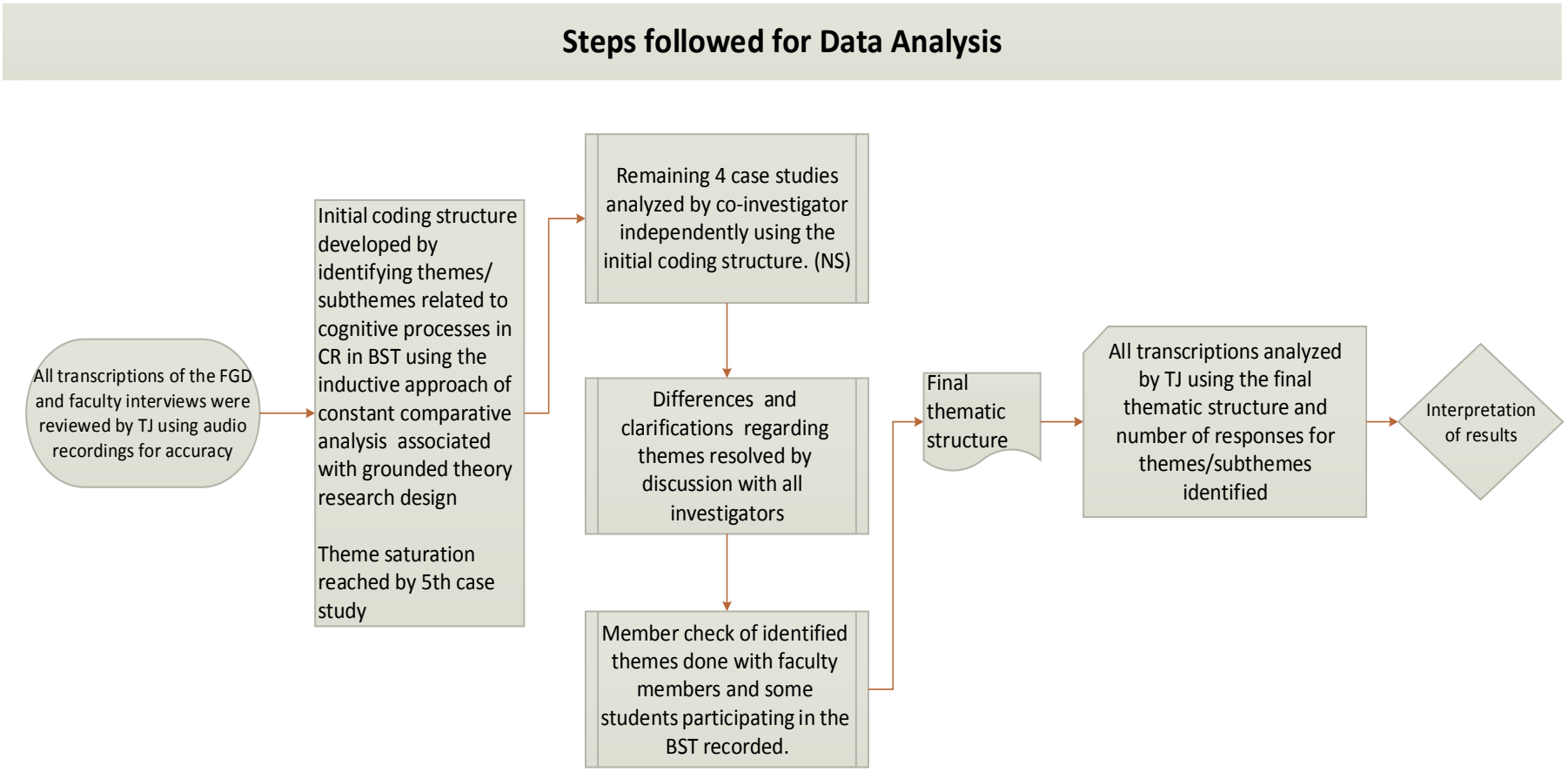

Figure III. BST: Bedside teaching session CR: Clinical reasoning FGD: Focus group discussion

IV. RESULTS

1. Description of data:

In the qualitative analysis of the faculty interviews and students' focus group discussions, several themes were identified which represent the learning processes recalled during CR instances in BST (Table I).

We also identified factors which influence the development of CR skills by students in BST (Table II). Although this was not part of our initial question, it underscores the contextual nature of the CR process demonstrated in Gruppen and Frohna's model of CR (Figure 1). Hence we included these in our results.

We used the Gruppen and Frohna's model for CR to elaborate on the instances of CR observed during the BST. We found evidence that all items of the CR model were represented in the CR instances we noted. We then looked for the features which assisted in the practice and development of the various items of the CR model in the BST experience. These factors which help in rehearsal and development of CR are the teaching and learning processes which foster CR skills in students.

The most frequent learning process related to CR, which was stressed in the BST, was the application of students' prior knowledge to patient care. Prior knowledge is one of the elements of the CR model and integrates with patient characteristics elicited immediately in the patient encounter to form the initial problem representation. We noted that application of prior knowledge was seen throughout the clinical discussion from the history and presentation to planning the treatment of the patient. The subthemes within this theme expand on the various ways that students' prior knowledge is activated. Teachers made a conscious effort to stimulate students to apply what they know to the patient's problems, throughout the bedside discussion, related both to specific issues for a particular patient and understanding general clinical concepts. Stimulation of application of students' knowledge

base to patients' individual problems was sometimes implicit, by urging students to make differential diagnoses or management plans, based on what they know of the patient. For example, faculty commented,

> *"I wanted them to think about what diseases they are thinking about and what can be the possibilities and what signs they can see on examination." "I try first that they come up with the right answer (diagnosis). At times they do."*

Sometimes stimulation of the application of prior knowledge was more explicit, by faculty asking students basic sciences or clinical questions and encouraging them to reply by applying what they have learned previously; as stated,

> *"I just drew the picture (of the uterus) to see if they could plan this surgery and apply their sense and basics knowledge." "I was trying to link the concept with the basics and seeing if they understood the physiology and histology as well as the management."*

The responses recalled by the students regarding activation of previously learned concepts during the discussion also reflect the significance of these learning processes in the development of CR. Questions promoting recall of previously learned subjects appeared to stimulate students to apply their knowledge during reasoning. As several students commented,

> *"In my mind, a table was coming, that I had seen in a book. I was trying to figure out that if the child's age is 1-6 month, then what was the upper limit of the respiratory rate in that table for diagnosis of pneumonia." "He (the teacher) asked why we were seeing the vitals. What he was asking for is why is the respiratory rate so important."* Students also used features remembered from previously seen patients to formulate their differential diagnosis and management plan.

"In a previous discussion on a previous patient, we talked about uterine artery embolization, but that was for fibroids. So it just popped up in my mind."

The second theme related to learning processes which facilitate CR is discussion of clinical concepts in the context of specific patients. The patient/situation characteristics is a component of our CR model which influences the problem representation during all the stages of the clinical discussion. The first subtheme, within this theme, highlights the importance of the student's data gathering skills, in particular, history taking and synthesis for developing CR. As faculty members commented,

"*If they miss the step (detailed history taking), then they will not be able to confirm their diagnosis."*

The students revealed an understanding of the significance of data gathering. As several students commented,

"Basically, he (teacher) was asking, and we were answering, the different types of pain; he was asking about the description of pain character (in our patient)."

Other subthemes, within this theme, focused on formulating patient-specific management plans and evidence-based practice. As several teachers commented,

"What I want from them is to understand what specific managements are appropriate for that particular patient." "We opened the book, and the incidence was 95/100000, so the chances of this being endometrial cancer were low."

The last subtheme, within this theme, revealed that even the discussion of more general medical concepts focused on the patient being discussed in the BST. As one teacher commented,

"Because some of those points like the vaccination schedule we discussed that are pertinent to this patient, apply to other (patients) also."

The third theme related to learning of CR is students giving justifications for their answers to queries during case discussions. The process of justifying choices and responses or seeking explanations represents the process of evaluation of our CR model. The problem representation which forms in the learner's mind as a result of the patient/situation and student's previous knowledge is constantly evaluated to identify the adequate problem to proceed with the CR process and come to some resolution and action or seek further information to refine the problem representation. The recall of cognitive processes, by both the teachers and students, indicated that questions asking for explanations of answers from students, promoted CR. As both a student and instructor commented,

"*I ask why a lot, ok. The reason behind this is that I put a lot of emphasis on developing critical thinking, make a habit in them to keep asking why." "Each time we mentioned a different examination finding, she asked us, why are you saying this?"*

Asking students for justification was also shown to be significant for formulating appropriate management plans based on the clinical details for a particular patient. As students commented,

"This made us think of all the possible facts that the management of the patient depends on, the age, the requirements of the patient, the surgical implications."

The fourth learning process for CR is correlation and differentiation of essential aspects of clinical topics. This teaching/learning process was actively encouraged by several teachers as a way to develop accurate problem representation, which is crucial to the process of CR in our model. However, this

learning process can be viewed as part of both problem representation and evaluation. As students commented,

> *“Each and every one of us, we took one scenario, saying what if we approach (the surgery) from here or from there and she (teacher) was discussing each scenario we told her separately.”*

As teacher x commented,

> *"Comparing, that we can take this (disease) on one side and another (disease) on the other side. So on one patient, we can discuss two of their topics.”*

The CR model formulated by Gruppen and Frohna underscores the contextual nature of the CR process. We did not ask any specific question regarding factors which may influence the CR process, but we noted any issues mentioned by the participants which promoted or hindered their CR processes (Table 2). An enabling factor may be a thoughtful selection of cases for bedside teaching based on complexity and learning objectives.

As one teacher commented,

> *“I wanted to begin with (a patient of) hydrocele, a simpler case. So we build up rather than jumping on to a complex case.”*

Encouraging brainstorming and student participation, and discussing the case at the bedside was also considered to facilitate CR by both teachers and students.

> *“If I just tell them they are wrong, and the answer is given by me (teacher), then there is not a lot of reasoning done on their (students) behalf.” “If we discuss it here (in a conference room) as we are doing, then I won't think. But if the patient is present then I can easily correlate the things with the patient."*

Time constraints, for the discussion and unavailability of patients, had a negative impact on the reasoning process. As stated by one student,

> *"Before us, a 4th-year student took the history of the same patient and a house officer and pulmonologist also came there (to the patient)."*

Table I: Learning processes demonstrated in bedside teaching which help students develop CR skills.

(n): Number of responses related to theme/subtheme.

Themes	Subthemes
Apply (students') previous knowledge to patient's clinical problem. (106)	**Formulate a differential diagnosis based on students' knowledge. (37)** *"I wanted to see if in their mind they understand the difference between each diagnosis."* *"I try first that they come up with the right answer (diagnosis). At times they do."* *"In my mind(student's), a table was coming, that I had seen in a book. I was trying to figure out that if the child's age is 1-6 month then what was the upper limit of the respiratory rate for diagnosis of pneumonia."* *" Sometimes, while presenting the case, then it comes to my mind that I missed it (the differential diagnosis)."* **Generate differential diagnosis based on the information (history/physical/investigations) gathered by the students. (30)** *"Once they complete presenting complaints, I want to ask them whether they have generated any differential."* *"I wanted them to think about what diseases they are thinking about and what can be the possibilities and what signs they can see on examination."* *"Our patient had a very severe clubbing. So we knew that we had seen it. It kept coming up that ultimately it would be that (diagnosis)."* *"Systematically, initially the general appearance of the patient and then the vitals and we went on (giving differential diagnoses)."*

Themes	Subthemes
	Link clinical concepts to basic science concepts. (28) *"I was trying to link the concept (of management) with the basics and seeing if they understood the physiology and histology as well as the management."* *"He asked why we were seeing vitals. One thing he was asking for is why is the respiratory rate so important."* *"Because now we had a drawing (of the uterus) in front of us, right?"* *"I just drew the picture (of the uterus) to see if they could plan this surgery and apply their sense and basics knowledge."* **Use features remembered from previously seen cases to formulate a management plan. (11)** *"So in another session, I had heard that before hysterectomy you should do a biopsy, So I said that first do biopsy, then, later on, you can do the hysterectomy."* *"In a previous discussion in a previous case, we talked about uterine artery embolization, but that was for fibroids. So it just popped up in my mind."*
View clinical concepts in the context of specific patients (67)	**Get thorough, detailed medical history. (09)** *" If they miss the step (detailed history taking), then they will not be able to confirm their diagnosis."* *"Basically, he (teacher) was asking, and we were answering, the different types of pain; he was asking what it was like, description of pain character."* *"I was thinking that why did I jump to the examination because history was not completed yet."* **Summarize patient's history. (09)** *" I repeated (a summary of the patient's history) because I wanted to emphasize, so they remember."* *"I wanted to emphasize that in history these points are important related to the complaints."* **Tailor the management plan to the patient being discussed. (19)** *"What I want from them is to understand what specific managements are appropriate for that particular patient."* *"Most of the time, the students they concentrate on one disease and forgot about the rest of the body."*

Themes	Subthemes
	" We must ask about social history, for financial reasons, if we are planning for surgery of something, that patient can afford it or not." **Anchor general clinical concepts to the patient. (15)** *"because some of those points like the vaccination schedule we discussed, that are pertinent to this patient, but it applies to other (patients) also."* *"First is thought of the age-related issues… (in this patient)"* **Apply literature/research to the patient's medical issues. (15)** *"The things are changing, so I wanted to stimulate them to read current literature and go through the recent advances in this particular field."* *"We opened the book, and the incidence was 95/100000, so the chances of this being endometrial cancer were low."*
(Students) Give justification for their answers to queries during case discussion (57)	**Justify each diagnosis in the differential diagnosis. (36)** *"I ask why a lot, ok. The reason behind is that I put a lot of emphasis in developing critical thinking, make a habit in them to keep asking why."* *"Each time we mentioned a different examination finding, she asked us, why are you saying this?"* *"Systematically, initially the general appearance of the patient and then the vitals and we (students) went on defending our diagnoses*." **Formulate management plan after reviewing all information (history, physical findings, and investigations). (21)** *"This made us think of all the possible facts that the management of the patient depends on, the age, the requirements of the patient, the surgical implications."* *"because history and then physical examination, that lays the foundation for what kind of lab test they want to do and then they can proceed with the management."* *"Based on what they have done in their history and examination, now they should prioritize their list of investigations."*

Themes	Subthemes
Correlate and differentiate essential aspects of clinical topics (27)	**Compare and contrast differential diagnoses. (06)** *"Comparing, that we can take this (disease) on one side and another (disease) on the other side? So on one patient, we can discuss two of their topics."* *"Things are remembered better when you compare with something else, covering two topics, and secondly, you are developing a differential (diagnoses) in your mind."* **Discuss pros and cons of the management plan. (10)** *"And for hysterectomy then, madam asked what can you tell me to support your plan …so we discussed the pros and cons of hysterectomy."* *"Each and every one of us, we took one scenario, saying what if we approach from here or from there and she (teacher) was discussing each scenario we told her separately."* **Correlate the history to previous medical illness, systemic review, and physical signs. (11)** *"I wanted them to focus so that they can correlate (with history) and maybe the disease which the patient is currently having may be the part of the previous disease process."*

Table II. Factors Influencing Learning of Clinical Reasoning by Students in BST.

Themes	Quotes
Thoughtful selection of teaching cases. (10)	*"I wanted to begin with hydrocele, a simpler case. So we build up rather than jumping on to a complex case."*
	"Secondly, because hydrocele is something in which there is an element of clinical methods for examining a hernia and hydrocele, so we can discuss clinical methods together with this."
	". We usually try and find the patient for whom during examination we find some physical findings."
Supporting brainstorming and participation. (13)	*"If I just tell them they are wrong, and the answer is given by me, then there is not a lot of reasoning done on their behalf."*
	"I want them to figure it out by themselves, let them think about it rather than right or wrong, they should be able to come up with certain answers then we can sort it out if the answers were appropriate or not."
Discussion of the case at the bedside. (09)	*"If we discuss it here (in the classroom) as we are doing, then I won't think. But if the patient is present then I can easily correlate the things with the patient."*
Time constrains and patient availability (07)	*"The main problem with them finding the solution is that it takes a lot of time."*
	"Before us, a 4th-year student took the history of the same patient and a house officer and pulmonologist also came there".

V. DISCUSSION

1. Relationship of data to conceptual frameworks

Our study shows the learning processes which help students develop CR skills during BST. The core concept that emerges from our study is that CR starts very early in the student-patient interaction and encompass cognitive processes related to diagnosis and formulation and review of management plans for the patient. We varied the conditions methodically, by including multiple specialties and bedside teaching sessions with different faculty members and students to explore the impact on the phenomenon being studied, i.e., clinical reasoning. Interestingly, although faculty from different disciplines appear to use somewhat different approaches to the history and physical examination, the learning processes used to facilitate development of CR in students are fairly uniform.

During the BST students are rehearsing their CR skills. This rehearsal affects the accretion and restructuring of memory schemas or illness scripts and integrated them with the history and physical examination, differential diagnosis, etc. The difference between this rehearsal of CR and the CR during the patient encounter is the discussion with the clinical teacher.

We used CR model formulated by of Gruppen and Frohna (Figure 1) as our conceptual framework to elaborate on the CR process recalled by the study participants. We found representation of all aspects of this model in our themes. The recalled cognitive processes during instances of CR throughout the BST helped to demonstrate teaching/learning practices which assisted in the development of CR during the BST.

The four themes related to cognitive processes recalled by students and teachers during instances of CR by students in BST are consistent with the items described in Gruppen and Frohna's CR model. According to this model, CR cannot be viewed as a linear process, rather, it is a recurring cycle of

reasoning triggered initially when the student tries to "make sense" of the patient information using his prior knowledge to come up with an initial problem representation. Research has shown that the CR process starts as soon as the first item of clinical information is available during the patient encounter (Gale & Marsden, 1982). This initial problem representation depends on the memory structures or schemas already developed in the student's memory from past experiences and the quick access of this information by specific triggers or forceful features that activate the schemas. This representation is then refined through iterative cycles of problem representation and evaluation until either there is a clear understanding of actions needed to resolve the problem, or it is determined that more information is needed to clarify the problem representation. In both cases, this may be the trigger for the next CR cycle. Our themes related to the application of prior knowledge to patient's problems, view clinical concepts in context of specific patients and correlate and differentiate essential aspects of clinical topics reflect features pertinent to problem representation.

Accurate initial problem representation is helpful for effective CR, and the way knowledge is arranged in problem schemata, and its accessibility, is crucial for the quality of the original problem representation (Bordage, 1999). We found several learning processes which appear to facilitate accurate problem representation by students and also develop more effective and efficient retrieval pathways to access clinical information from memory during patient encounters. The teachers encouraged students' attempts to use previously learned clinical and basic sciences concepts or features remembered from patients seen in the past to formulate differential diagnoses and management plans. The questions and comments by teachers also show that they stimulated students to make patient-specific diagnostic and management decisions. This was evident even when the learning goal was acquiring general concepts such as use of evidence bases medicine. We also noted that even when discussing clinical topics during BST, the teachers used the clinical features found in the patient presented by the student to correlate and differentiate essential aspects of the topics.

In our CR model, immediately after the individual forms a problem representation, this is evaluated to determine if the problem representation is acceptable enough to process to some action/or further information gathering by evaluation. This process of evaluation may be subconscious and almost automatic for familiar problems, or it may be more deliberate for unfamiliar, unclear or complex problem. Our theme of students giving justification for their CR explicitly depicts this process of evaluation. However, all the other themes in our results are also displaying evaluation as an integral aspect of the recalled thinking processes. A learning process which helps students develop the process of evaluation is encouraging students to explain their responses during CR at all stages of the BST discussion. The teachers specially emphasized that students justified their choices about further action plans based on the finding related to their patient. Therefore, similar to problem representation, evaluation was also focused on patient-specific responses rather than general answers.

Context is a fundamental item of Gruppen and Frohna's CR model which impacts all aspects of this model, including problem representation, evaluation, and information gathering. Context includes factors such as the social context of the problem and the affect and motivation of the learner. CR has been identified as contextual (Charlin, Boshuizen, & Custers, 2007; Norman G., 2005) and case specific (Elstein, 2009). Consequently, every patient seen by the learners is cognitively related to previous medical problems and hence adds new perspectives or modifies previous illness scripts. The organization of clinical knowledge in memory and its accessibility varies from person to person which explains the variability of thinking between individuals when exposed to the same set of clinical information (Grant & Marsden,1988; Grant & Marsden, 1987). In our study, while some of the factors influencing the CR process were explicit (Table 2), the CR process cannot be viewed as an isolated phenomenon without accounting for the influence of the patient-student-teacher interaction in the work-based setting of the patient encounter and the interplay of these interactions with existing prior

knowledge of the learner. The CR instances and the subsequent discussion noted throughout the BST session revolve around the actual patient assessed by the students for the BST.

2. Implications:

The data we obtained in our study helps to describe in detail what happens in BST which relates to CR. We derived several implications which can help undertsand the learning processes related to CR in BST.

Implication 1: A lot happens in our BST that relates to CR. Therefore, BST is potentially a good context for teaching and learning CR, because there are many opportunities

Implication 2: The CR in our BST is consistent with the Gruppen & Frohna model. Therefore, it may be effective (useful) to use that model to guide interventions to improve teaching and learning of CR. For example, explicitly introducing the model to teachers and students, building rubrics for BST use that are based on the model components.

Implication 3: If we assume (because this is not tested in the study) that our BST is currently effective in teaching and learning CR, then our description of our BST provides a sufficient list of valuable practices (all themes and subthemes) for teaching and learning of CR in BST. Sufficient, not necessary - we do not know which of these are really the important or critical ones, but we do know (under the assumption of current effectiveness) that taken together they promote teaching/learning CR.

3. Limitations:

There are some inherent limitations to our study. The student or faculty may supplement incomplete memories during the recall and introduce secondary ordering and bias in cognition by added

reflections during SR (Yinger, 1986). We took several measures to minimize the limitations of SR, which were described in detail in the methods. Our study was conducted with a relatively homogeneous group of students in the fifth (final) year of medical school in Pakistan where the students may come from similar backgrounds, education levels, and ages. It would be interesting to see if bedside discussions in students with more diverse backgrounds would demonstrate additional themes related to learning processes facilitating CR skills.

In summary, our study demonstrates learning processes which help develop CR skills in medical students during BST. It is likely that our findings can be extrapolated to other workplace-based settings where students interact with patients. We focused on thinking processes of both students and teachers as the perspective of both can describe the teaching and learning in a more holistic manner. Further research is needed in naturalistic settings to extend understanding of teaching/learning of clinical reasoning. A larger, multi-center study with learners at various stages of training may further clarify the processes and factors influencing problem representation and evaluation in CR. Such research will serve to increase our understanding of the complex processes involved in CR which should translate to enabling CR skills in learners.

VI. CITED LITERATURE

Abdool, M. A., & Bradley, D. (2013, Nov). Twelve tips to improve medical teaching rounds. *Med Teach, 35*(11), 895-9.

Bordage, G. (1999). Why did I miss the diagnosis? some cognitive explanations and educational implications. *Academic Medicine, 74*(10), S138-43.

Calderhead, J. (1981). Stimulated recall: A method for research on teaching. *British Journal of Educational Psychology, 51*(2), 211-217.

Celenza, A., & Rogers, I. R. (2006, Oct). Qualitative evaluation of a formal bedside clinical teaching programme in an emergency department. *Emerg Med J, 23*(10), 769-773.

Charlin, B., Boshuizen, H., & Custers, E. J. (2007). Scripts and clinical reasoning. *Medical Education, 41*, 1178–1184.

Charlin, B., Tardif, J., & Boshuizen, H. P. (2000). Scripts and medical diagnostic knowledge: theory and applications for clinical reasoning instruction and research. *Academic Medicine, 75*(2), 182-190.

Corbin, J. M., & Strauss, A. (1990). Grounded theory research: Procedures, canons, and evaluative criteria. *Qualitative sociology, 13*(1), 3-21.

Crabtree, B. F., & Miller, W. L. (Eds.). (1999). *Doing qualitative research.* Sage Publications.

Custers , E. J., & Boshuizen, H. P. (2002). The psychology of learning. In E. J. Custers, H. P. Boshuizen, G. R. Norman, C. P. Van der Vleuten, & D. I. Newble (Eds.), *International handbook of research in medical education* (pp. 163-203). Dordrecht, The Netherlands: Kluwer.

Custers, E. J., & Boshuizen, H. P. (2012). The psychology of learning. In G. R. Norman, C. P. Van der Vleuten, & D. Newble, *International handbook of research in medical education* (Vol. 7, pp. 163-204). Springer Science & Business Media.

Cutrer , W. B., Sullivan , W. M., & Fleming, A. E. (2013, Oct). Educational strategies for improving clinical reasoning. *Curr Probl Pediatr Adolesc Health Care, 43*(9), 248-57.

Dickson, J., McLennan, J., & Omodei, M. M. (2000). Effects of concurrent verbalization on a time-critical, dynamic decision-making task. *The Journal of general psychology, 127*(2), 217-228.

Elstein, A. S., & Schwartz, A. (2002, March 23). Clinical problem solving and diagnostic decision making: selective review of the cognitive literature. *BMJ, 324*(7339), 729-32.

Elstein, A. S., Sprafka, S. A., & Bordage, G. (1979). Problem Solving: Applications of Research to Undergraduate Instruction and EvaluationAbstract . In *Innovations in Education & Training International* (p. 16(4)). Taylor & Francis.

Ende, J. (1997). What if Osler were one of us? Inpatient teaching today. *J Gen Intern Med, 12*(Suppl 2), S41–S48.

Ericsson, K. A. (2008). Deliberate practice and acquisition of expert performance: a general overview. *Acad Emerg Med , 15*(11), 988–94.

Eva, K. (2005). What every teacher needs to know about clinical reasoning. *Medical Education, 39*, 98–106.

Gale, J., & Marsden, P. (1982). Clinical problem solving: the beginning of the process. *Medical Education, 16*, 22-26.

Gale, J., & Marsden, P. (1984). The role of the routine clinical history. *Medical Education, 18*, 96-100.

Gass, S. M., & Mackey, A. (2000). *Stimulated recall methodology in second language research.* Routledge.

Gonzalo, J. D., Heist, B., Duffy , B. L., Dyrbye, L., & Et al. (2013, Mar). The art of bedside rounds: a multi-center qualitative study ofstrategies used by experienced bedside teachers. *J Gen Intern Med, 28*(3), 412-20.

Grant, J., & Marsden, P. (1987). The structure of memorised knowledge in students and clinicians: An explanation for diagnostic expertise. *Medical Education, 21*, 92-98.

Grant, J., & Marsden, P. (1988). Primary knowledge, medical education and consultant expertise. *Medical Education, 22*, 173-179.

Gruppen , L. D., & Frohna, A. Z. (2012). *Clinical Reasoning.International Handbook of Research in Medical Education,* (Vol. 7).

Harris, I. (2011). Conception and Theories of Learning for Workplace Education. In C. J. Hafler (Ed.), *Extraordinary learning in the workplace* (Vol. 6, pp. 39-62). Springer.

Hoffman, R. R., Shadbolt, N. R., Burton, A. M., & Klein, G. (1995). Eliciting knowledge from experts: A methodological analysis. *Organizational behavior and human decision processes, 62*(2), 129-158.

Irby, D. M. (1994). Three exemplary models of case-based teaching. *Academic Medicine, 69*(12), 947-53.

Kagan, N., Krathwohl, D., & Miller, R. (1963). Stimulated recall in therapy using video tape: A case study. *Journal of Counseling Psychology, 10*(3), 237.

Kassirer, J. P. (2010). Teaching Caselinical Reasoning: Case-Based and Coached. *Academic Medicine, 85*(7), 1118-1124.

LaCombe, M. A. (1997). On bedside teaching. *Annals of Internal Medicine, 126*(3), 217-220.

Lyle, J. (2003). Stimulated recall: A report on its use in naturalistic research. *British educational research journal, 29*(6), 861-878.

Mamede , s., Schmidt, H. G., & Penaforte , J. C. (2008, May). Effects of reflective practice on the accuracy of medical diagnoses. *Med Educ, 42*(5), 468-75.

Marcum, J. A. (2012, Oct). An integrated model of clinical reasoning: dual-process theory of cognition and metacognition. *J Eval Clin Pract, 18*(5), 954-61.

Nair, B. R., Coughlan , J. L., & Hensley, M. J. (1998). Impediments to bed-side teaching. *Med Educ , 32*, 159–162.

Nair, B. R., Coughlan, J. L., & Hensley, M. J. (1997). Student and patient perspectives on bedside teaching. *Med Educ, 31*, 341–346.

Norman, G. (2005). Research in clinical reasoning: past history and current trends. *Medical Education, 39*, 418-427.

Patton, M. Q. (1999). Enhancing the quality and credibility of qualitative analysis. *Health Services Research, 34*(5 Pt 2), 1189.

Pelaccia, T., Tardif, J., Triby, E., & Charlin, B. (2011). An analysis of clinical reasoning through a recent and comprehensive approach: the dual-process theory. *Medical Education Online*, DOI: 10.3402/meo.v16i0.5890.

Pope, C., Ziebland, S., & Mays, N. (2000). Analysing qualitative data. *BMJ, 320*(7227), 114-116.

Rumelhart, D. E., & Norman, D. A. (1976). *Accretion, tuning and restructuring: Three modes of learning (No. 7602).* California Univ San Diego La Jolla Center For Human Information Processing.

Rumelhart, D. E., & Norman, D. A. (1981). *Analogical processes in learning.Cognitive skills and their acquisition.*

Schmidt, H. G., & Boshuizen, H. P. (1992). Encapsulation of biomedical knowledge. In *Advanced models of cognition for medical training and practice* (pp. 265-282). Berlin Heidelberg: Springer.

Spencer, J. (2003). Learning and teaching in the clinical environment. *British Medical Journal, 326*(7389), 591.

Steward, D., Bordage, G., & Lemieux , M. (1991). Semantic structures and diagnostic thinking of experts and novices. *Academic Medicine, 66*(9), S70-S72.

Williams , K. N., Ramani , S., Fraser , B., & Orlander , J. D. (2008, Mar). Improving bedside teaching: findings from a focus group study of learners. *Acad Med, 83*(3), 257-64.

Yinger, R. J. (1986). Examining thought in action: A theoretical and methodological critique of research on interactive teaching. *Teaching and teacher education, 2*(3), 263-282.

VII. VITA

TARA JAFFERY, M.D.

House No: 303, Street 58, Sector I-8/2, Islamabad, Pakistan.
Contact: 923008502263, 00966565899565.
tarajaffery@gmail.com, jafferyta@ngha.med.sa

EDUCATION:

Masters in Health Professions Education, University of Illinois, Chicago, USA, 2017 through the International Fellowship in Medical Education (IFME) from FAIMER.

FAIMER Institute fellowship, 2007, from The Foundation for Advancement of Medical Education and Research (FAIMER).

Diplomate American Board of Internal Medicine (DABIM).

1997- 2007. Recertified in 2009- 2020.

M.D. Residency in Internal Medicine at the University of Illinois College of Medicine, Chicago, USA. July 1994 to August 1997.

M.B.B.S. Sind Medical College, Karachi, Pakistan in 1992.

PROFESSIONAL EXPERIENCE

Academic Experience:

Joint Faculty, Internal Medicine, and Coordinator, Respiratory system block, King Saud bin Abdul Aziz Medical University, Jeddah (KSAU-J), female college 2016-2017.

This includes taking clinical sessions and supervision of the delivery of the curriculum, ensuring clinical skills sessions for clinical competencies, and assessment of the block.

Professor of Medicine, Shifa College of Medicine from January 2012 to March 2014.

I regularly interacted with clinical year students in my Inpatient service months and outpatient clinic and also conducted final year morning reports and case-based discussions. I was also involved in the Postgraduate Internal Medicine residency program and supervised Internal Medicine. I like to maintain an informal and friendly environment in these interactions and facilitate the development of clinical reasoning skills, ethical practice and professionalism through discussion and cognitive feedback. These sessions are of great value to me because students stimulate me to reflect on everyday practice and keep learning.

Associate Professor of Medicine, Shifa College of Medicine, Islamabad from January 2007 to December 2011/Assistant Professor of Medicine, Shifa College of Medicine, Islamabad from April 2001 to December 2006.

Responsible for teaching and assessment of undergraduate and postgraduate medical students in Medicine clerkship.

Assistant Dean, Curriculum development, Shifa College of Medicine, Islamabad from January 2009 to September 2012.

This position was my most challenging and rewarding academic experience. I worked with the faculty for the development and implementation of the Shifa College of Medicine system-based, integrated, modular curriculum. My responsibilities included structuring the overall organization of the MBBS curriculum, working with faculty to develop individual courses and establishing program evaluation strategies for formative evaluation of the curriculum. As part of the DHPE, I also participated in faculty development related to learning and assessment strategies which are vital for the implementation of curriculum change and innovation.

Coordinator, Integrated Curriculum, Shifa College of Medicine, Islamabad from September 2008 to November 2009.

Shifa College of Medicine implemented a new, system-based, integrated Modular curriculum in 2008. I was Coordinator Integrated curriculum during the second year of implementation, to facilitate the

planning and review of modules with the faculty including the review of objectives, modes of delivery and examination blueprint of the ongoing modules.

Director SCIL (Shifa Clinical Skills and Informatics Laboratory), Shifa College of Medicine from December 2006 to June 2012.

I was involved in the planning and development of the SCM Clinical Skills Laboratory which was established in 2004. With the integrated curriculum, the Clinical Skills Laboratory was a valuable resource for preclinical students to bring relevance to basic sciences courses and the clinical skills sessions became a regular part of all the system based modules of the integrated curriculum starting from the first year of MBBS. The SCIL is also being used for the Integrated Practical Examinations (IPE) and OSCE examinations. The informatics section of the SCIL is involved with designing and delivers workshops on computer and presentation skills, development of educational resources and workshops on search strategies, EBM, SPSS, research strategies for the faculty and students.

Clinical Experience:

Consultant, General Internal Medicine, King Abdul Aziz Medical City, National Guards Health Affairs, Jeddah, Saudi Arabia from May 2014 to date.

Inpatient and outpatient responsibilities for providing medical care to general internal medicine patients in KAMC-NGHA Jeddah, which is a tertiary care, JCI accredited tertiary care hospital. In addition, supervising both undergraduate MBBS students and post graduate medicine trainees in internal medicine.

Consultant in Internal Medicine, **Shifa International Hospital, Islamabad from October 1999 to March 2014**.

Inpatient and Outpatient responsibilities for providing medical care to general internal medicine patients

Residency training in Internal Medicine at The University of Illinois, College of Medicine at Chicago**. July 1994 to August 1997.**

PROFESSIONAL LICENSE:

Pakistan Medical and Dental Council Registration No**. 2448-S**

ABIM certification: **178790**

Saudi Boards: **14-J-M0026002**

LANGUAGES:

Proficient in English, Spanish and Urdu languages

PUBLICATIONS:

Ayub, R. A., Jaffery, T., Aziz, F., & Rehmat, M. (2015, May-Aug). Improving health literacy of women about iron deficiency anemia and civic responsibility of students through service learning. Educ Health (Abingdon)., 28(2), 130-7.

Rauf, A., Baig, L., Jaffery, T., & Shafi, R. (2014, Jan-Apr). Exploring the trustworthiness and reliability of focus groups for obtaining useful feedback for evaluation of academic programs. Educ Health (Abingdon), 27(1), 28-33.

Rauf, A., Tayyab, A., & Jaffery, T. (2012, Nov). Using inception to sensitise learners to doctor roles. Med Educ. , 46(11), 30-1.

Saeed, N., Jaffery, T., & Quadri, K. H. (2012, Aug). Exploring the process of final year objective structured clinical examination for improving the quality of assessment. J Pak Med Assoc., 8(797-802).

Tariq, N., Ayub, R., Jaffery, T., Rahim, F., Naseem, F., & Kamal, M. (2011, Apr). Efficacy of levonorgestrel intrauterine system (LNG-IUS) for abnormal uterine bleeding and contraception. J Coll Physicians Surg Pak. , 21(4), 210-3.

Zaidi, Z., Jaffery, T., Shahid, A., Moin, S., Gilani, A., & Burdick, W. (2012, Mar). Change in action: using positive deviance to improve student clinical performance. Adv Health Sci Educ Theory Pract. , 17(1), 95-105.

Aslam, R., Jaffery, T., & Zaidi, Z. (2011). Service-learning: increasing civic responsibility in Pakistani students. Med Educ. , 45(5), 524.

Zaidi, Z., Jaffery, T., & Moin, S. (2010, May). Using positive deviance to improve student performance. Med Educ. , 44(5), 495.

Quadri, K. H., Rahim, F., Yawar, A., Jaffery, T., Zaidi, Z., & Iqbal, M. (2008, Nov). The structure and function of a new clinical skills and medical informatics laboratory (SCIL) in a developing country--a two year institutional experience. J Pak Med Assoc. , 58(11), 612-5.

Quadri, K. H., Jaffery, T., Yawar, A. Y., & Rahim, F. (2007, Jun). Preliminary experience with a new medicine morning report format incorporating multimedia and up-to-date. J Pak Med Assoc. , 57(6), 320-1.

Tariq, N., Jaffery, T., Ayub, R., Alam, A. Y., Javaid, M. H., & Shafique, S. (2006, Mar). Frequency and antimicrobial susceptibility of aerobic bacterial vaginal isolates. J Coll Physicians Surg Pak. , 16(3), 196-9.

Jaffery, T., Tariq, N., Ayub, R., & Yawar, A. (2005, Nov). Frequency of hepatitis C in pregnancy and pregnancy outcome. J Coll Physicians Surg Pak. , 15(11), 716-9.

Adil, M. M., Yawar, A., & Jaffery, T. (2005, May). Knowledge of type 2 diabetic patients about their illness: pilot project. J Pak Med Assoc. , 55(5), 221-4.

Iqbal, M., Jaffery, T., & Shah, T. A. (2002, Apr-Jun). Isolated pleural fluid lactic dehydrogenase level: a cost effective way of characterizing pleural effusions. J Ayub Med Coll Abbottabad. , 14(2), 2-5.