Tutoring Strategies for Effective Instruction in Internal Medicine

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1 Introduction

Medicine, as a discipline, has a long-standing tradition of modeling expertise through tutorials provided in clinical practice. As lay-people many of us have witnessed first hand the bedside teaching that physicians provide to medical students, or we have viewed the Hollywood version of modern day medical practice through ER or other popular series. There is a great deal of variation in the type and quality of medical tutorials, particularly in terms of the pedagogical theory that guides the learning experience. We are interested in documenting these naturally occurring tutorial dialogues as a first step in developing a model for scaffolding learning in small group problem based settings in medicine. Our long-range goal is to develop this tutorial model into a computer based learning environment that can help internal medicine students in their clinical problem solving skills.

Pedagogical competence, as a construct, is still being defined. Shulman [1] described pedagogical competence as a combination of pedagogical knowledge and pedagogical content knowledge, knowing how and what to teach as being tightly linked. When examining tutorial dialogues we need to be aware of the tutor's goals for instruction. These goals can be revealed through classroom discourse, which reflects the instructor's pedagogical beliefs and strategies for instruction. There are different theoretical "lenses" that can be used to analyze these data. The "cognitive apprenticeship" lens is used in this analysis. Apprenticeship training exists in many fields, and the training generally involves an expert who demonstrates complex skills to novices in the context of performing a task. The expert tends to decompose a complex task into parts so that even the most novice member of the team can participate. Lave & Wenger [2] term this "legitimate peripheral participation," in that every member of the team is productive and contributes to an overall goal. For instance, an expert tailor may start a novice with the task of hemming a pair of pants before moving to the more complex task of cutting a suit pattern. According to Lave & Wenger, apprenticeship methods consist of observation, coaching and practice (or modelling, coaching and fading). Modelling consists of observing the master, then the apprentice attempts the target process with guidance and help from the master (coaching). A key aspect of coaching is the scaffolding, in the form of reminders and help, that the novice requires to perform the entire task. Once learners have a grasp of the target skill, the master reduces his participation (fades), providing only limited hints.

A cognitive apprenticeship model uses these same methods but emphasizes the modeling of cognitive rather than physical skills [3], [4]. This type of model can be used as a template to analyze clinical settings where senior physicians model the cognitive competencies of diagnostic reasoning to their students. In this paper, we examine a medical instructor's classroom discourse from a tutorial perspective that demonstrates cognitive apprenticeship methods. The primary step in developing this type of instruction is finding a subject-matter expert who can articulate the inner workings of his or her mind. In examining naturally occurring tutorials it may be possible to see how cognitive competencies in medicine can be modeled, coached, and faded to medical students. Collins et al. [3] suggest that expert tutoring often consists of articulating a conceptual model which then serves as an advanced organizer. Learners are thereby provided with an interpretive structure with which to make sense of tutorial feedback. Conceptual models provide the "big picture" in which new information can be linked thus providing a mechanism for students to self-assess and monitor their own skills.

A key element in the cognitive apprenticeship model is the social context in which learning takes place. Lave [5] argues that learning is *situated* in that it is a function of the activity, context, and culture in which it occurs and cannot be separated out and studied meaningfully. According to Lave & Wenger [2] learning originates within *communities of practice* where individuals share purposeful and patterned activity. In the internal medicine example, an instructor and small group of students work together to solve patient cases. Students will be tutored by the instructor but will also have other cognitive models that come from their peers who may demonstrate different stages of development. This type of community provides opportunities for peer tutoring as well as expert tutoring.

2 The Instructional Context

Many researchers suggest that medical education should put more emphasis on teaching the *clinical reasoning process* since it is central to medical practice and is rarely taught explicitly [6]. Many instructional problems plague undergraduate medical education in general [7], [8]:

- classroom instruction is not standardized,
- instruction is fast-paced although content is difficult,
- student access to experts is limited, and
- student access to actual patient cases is limited to those seen during clinical rounds and in lectures.

Many medical schools have turned to a problem-based learning (PBL) approach to teaching [9], [10], [11]. In PBL settings students are presented with "real-life" cases that require defining the problem, creating hypotheses, gathering and analyzing data, and evaluating or justifying solutions collaboratively [9]. PBL is consistent with the constructivist and situated learning views [12], [13] as it designed to promote active participation in problem solving in authentic contexts. Importantly, PBL instructional models differ but the general approach in this type of instruction is student-centered, small group, problem-based learning activities. In the typical scenario, a small group of students are assigned particular roles to play in a collaborative problem-solving activity [14], [10], [15]. A major goal of the PBL approach in medicine is to produce practitioners who can function cooperatively in real-world problem solving situations during their medical careers. The PBL approach is being intensively studied for a variety of purposes by both educational researchers [16], [17] and medical educators [18], [19].

In this study, we examined one expert medical instructor’s[1] pedagogical approach to teaching clinical problem solving skills. This model can be regarded as a “hybrid PBL approach” in that while it is centered on collaborative problem solving with authentic problems, it is more directive or instructor-controlled than PBL models typically are. This approach is structured and the tutorial strategies are based on his conceptual model of clinical problem solving. The problems used in his sessions are real cases rather than simulated ones, and the students were required to actually conduct real patient histories and interpret actual patient data outside of class. In this study, we were interested in how his instructional goals were communicated and achieved through tutorial dialogue.

According to this model, the clinical problem-solving task is composed of 10 phases as follows:

1. bedside history taking
2. bedside physical exam
3. case presentation - giving an oral presentation of the case
4. problem list - selecting and prioritizing relevant information from raw patient data
5. differential diagnosis for each problem
6. select laboratory tests - how to use a problem list and differential diagnosis to generate a probable list of tests
7. revise initial PL based on new information - based on results of lab investigations and the patient’s stay in the hospital
8. written case reports
9. learning in a clinical setting – determining how to learn effectively in this setting
10. integration exercises- how to reason through alternative patient presentations

This model is consistent with the medical literature in that it emphasizes the importance of the medical interview. Researchers have found that 70% of patient diagnoses are made on the basis of this interview [20]. Primary physicians spend the largest part of their clinical time talking with patients and generating

[1] The analysis in this paper is based on the second author’s classroom practice.

diagnostic hypotheses based on patient history which is mostly acquired through dialogue [21]. Understanding these dialogues is important for improving instruction in the clinical setting.

The class consisted of four first-year medical students and an expert instructor. The classroom dynamic was based on the cognitive apprenticeship model where a community of learners work together to solve a problem. In this case, the group's task was to construct a list of patient problems that would lead to a diagnosis (number 4 in the above list). The instructor assigned roles to each of the students. One student was asked to present an actual patient case to the group, describing the patient's relevant medical history and current situation. A second student was then asked to summarize the same case based on the verbal account of the first student. Next, a third student was asked to produce a problem list for the patient on the blackboard with the assistance of the other students in the group. Finally, the fourth student was asked to lead the group in developing a list of differential diagnoses for the case. During these exercises, the instructor provided both case-specific feedback and more general information relevant to developing a problem list.

3 Data Analysis

The data for this study consisted of videotape of one classroom session that occurred in the second week in a 6 week course. The session was the second one that dealt with *developing a problem list.* The videotape was analyzed to determine the nature of the tutorial dialogues, including the types of tutorial actions used. The verbal data from the videotape were analyzed focusing on the discourse and knowledge of the medical tutor as well as the students in that classroom. The analysis examines what, how, and when the medical tutor intervenes and how tutorial feedback changes over time. For example, how does the tutor help learners make incremental changes to their performance that will help them to become more competent in terms of their diagnostic reasoning? Do the dialogues indicate that the tutor changes tactics based on student differences? Does the tutor demonstrate tutorial strategies shown in the cognitive apprenticeship literature? Examples include those of abstracted replay [22] and post-mortem analysis [23]. An abstracted replay can serve to focus students' observations on how their strategies differ from an expert's performance. Schoenfeld [23] points out that a recounting of the problem solving process can be done by highlighting the solution methods in terms of how generalizable they are, which heuristics are reasonable, and what alternative strategies might be useful. This type of post-mortem analysis can be done by the expert and by students, providing opportunities for reflection on the problem solving process.

4 The Nature of Expert Scaffolding in Problem Based Learning Situations

The key learning activity for the students in the group was active engagement in reasoning about a case, and the instructor's basic role was to facilitate or scaffold this learning. Several types of tutorial actions are observed in the data, which can be categorized as *general* or case-independent and *case-specific*. At the higher or *general* level, the instructional goal is for learners to become able to perform the 10 phases listed above in their minds independently, and the goal of tutoring actions is to facilitate the development of this competency. In the sample data, the instructor explicitly tells the students that the purpose of the course is for them to become independently able to reason through a case (take a patient history, do a physical exam, develop a problem list, etc.). He also explicitly informs them that his instructional approach will involve using a variety of tutorial actions, initially modeling the process for them and then supporting or scaffolding them as they work through cases as a group. The instructor explicitly states this goal and describes his intention to move the students through the phases as a group first and to provide them with the support they need to function independently on the tasks. When they are engaged in actively solving cases, he interjects at strategic points to relate the events of the particular case back to the general process of solving a case. Several types of tutorial discourse are described and examples are provided in Table 1.

In terms of *case-specific* scaffolding, the sample data shows several strategies including hints, questioning, and explicit telling that the instructor uses in order to ensure that students understand critical points about the particular disease and its treatment (e.g. dangers to the patient). At some points he also makes modifications to the case in an impromptu fashion. In this manner, he scaffolds learning from the specifics of a single patient with a particular disease to a broader understanding of the disease and its variations.

The actions of the instructor will be examined in further detail in the final version of this paper. However, several types of tutorial actions found in the protocol are briefly described here, each of which corresponds to specific instructional principles as described earlier in this paper.

Table 1 provides a brief synopsis of the types of tutorial actions identified with examples of discourse from the protocol. The top of the table provides examples in keeping with the cognitive apprenticeship model where the instructor models, scaffolds and fades the assistance he provides to individuals and the group. Metacognitive prompts were identified in the form of explicit hints as to what to do next, and specific pointers to expert –like cognitive actions. The tutor explicitly models what is relevant and what is a priority for the case at hand. In this manner students can compare their own thinking skills with that of an expert. The tutor provides feedback that helps students transfer what they have learned in one situation to other cases (see drawing generalizations). Explanations consisting of helpful declarative or procedural knowledge, are also frequently provided by the tutor. Examples of community building are identified as well where the tutor encourages collaboration and consensus building. The protocol analysis also gave examples of conceptual model building and the use of abstracted replays. For example, conceptual model building in this protocol consists of the tutor describing his entire instructional model to the students and showing where the daily activity fits into the model. Finally we found evidence that the tutor makes use of what Schoenfeld [23] termed a post-mortem analysis. This segment in the table indicates an extensive recounting of the problem solving process, where problem solving methods are discussed along with alternative strategies that could assist in the overall reasoning process.

Table 1. Types of Tutorial Actions and Examples

Tutorial Action	Example Discourse
Modelling (explicit plan for)	T: I'm going to walk you through all of those (problem list, differential diagnoses, lab tests), but eventually you'll be able to do that, that's what a real doctor does.
Scaffolding	T: So the most likely diagnosis would be? What you do is you (write) your most likely diagnosis first and then your differential diagnosis underneath?
Fading (across sessions)	T: This time I am not going to help you as much as I did last week.
Metacognitive	T: ok so that's a decent list of the problems – what's the next step after getting all the problems up on the board? S4: we have to organize them T: putting them in the right order
Prioritizing patient problems	T: We know that young people can really tolerate severe degrees of anemia for quite a long time – it's not good but it's not going to kill her whereas malnutrition the way she is right now (could).
Drawing generalizations (going beyond present problem)	T: Now let's say she's 76 years old and has coronary artery disease well then anemia becomes very important because she could have a myocardial infarction.
Explanation (providing background knowledge)	T: You're right you wouldn't expect, well it could last this long, usually shigella is extremely acute, much more acute even than this, it doesn't give...months worth of slowly getting worse
Encouraging collaboration in a community of learners	T: Let's make it a vote, do you want to make it a vote, how many people vote for malnutrition number 3 hands up? …You can use the group to help you out here, I'm not leaving you up there naked you know alone, try to write down a few that you think, and make the group work for you to come up with some other ones.

Conceptual model bulding	T: Now the next step after this is differential diagnosis (and) you have to then order laboratory tests for your patient. How do you decide which laboratory tests to order? Well you ask yourself what your differential diagnosis is and do tests for each of those to help you rule in or rule out, or do more history or physical to rule in or rule out each of the possibilities that you brought up in your differential diagnosis T: so there's a reason why I'm torturing you like this, because we're going to get to a point ... (where) I will expect you to do a problem list in your mind, do a differential diagnosis in your mind, and then come out with the laboratory investigation.
Post-mortem analysis Note: T = tutor, R & O= students	T: so what are you going to take home from this problem solving exercise? R: I realize that you can sit there and think about it …when you get into a situation with a group you realize how much you've missed... T: everybody thinks differently and everybody will attack a problem in a different way, so there's an advantage to having other people listen to your problem…that's why in medicine quite often we ask for consults ... T: Now why do you think they came up with all of those extra things that you didn't think about? … T: the case presented to you was a mess a patient that has disorganized symptoms, disorganized physical findings, you had to do the work …so you extracted all that information, sort of organized it, and then served it up to them …they could use their memories and their minds were freed up to think about the case. T: what else did you get out of doing problem lists this time? O: it makes you think of things like more systematically , you get a lot out of it, I think the first time we did it we didn't know what to expect, what to look for. T: mm hmm O: whereas this time when we wrote down a problem list we logically placed it in a certain order that makes sense. T: yeah I that's I was surprised because all four of you attacked the problem more vigorously than you did last week, you were going for the jugular on this problem T: that's the way clinical medicine is, you attack the first problem hard and then everything else falls into place and that's a lot of what you did here. T: ok again so just to summarize the when you do a problem list that's the hardest part of doing a history and physical, the HPI is the second hardest part, but the hardest thing that's going to take the most thought now at your level and that's going to take the most angst to get done is going to be the problem list.

5 Future Directions

This paper has presented an initial examination of tutoring strategies in a small group clinical setting. The instructional setting was described as an expert medical instructor's hybrid-PBL instructional model with strong cognitive apprenticeship underpinnings. A brief description of the types of tutorial actions have been identified with accompanying examples of classroom discourse. The results of the study are informative in terms of identifying types of tutorial actions that make up the instructional component in this setting. Follow-up studies will focus on the tutoring experience over time so that appropriate models of scaffolding and fading can be developed that reflect the adaptivity of tutorial feedback in terms of instructional content and background knowledge or ability differences in students.

This study examines naturally-occurring tutorial dialogues as a first step towards developing computer-based learning environments that can help internal medicine students to develop their clinical problem solving skills. The potential benefits of computer-based learning environments for medical domains are considerable [24]. They can be designed to provide safe practice environments for learners to develop their understanding of patient data in realistic contexts and to practice their diagnostic reasoning [25], [26]. For medical educators, computers offer a promising solution to one pervasive problem that plagues medical education, the lack of standardization in both cases and instruction.

Several promising initiatives in computer-based instruction for medical domains have begun in recent years [27], [28], [25], [29], [30], [31], [32], [33]. The current study will add to this new domain by developing a model of human tutoring as a starting place for computer tutorial models in internal medicine.

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