

Tracking Student Propositions in an Inquiry System

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General description

This work fosters active inquiry-oriented learning in human biology. Participants will interact with 1) a medical case; and 2) a set of software tools to support participant inquiry. They will diagnose a patient's disease, formulate open questions about it, advance hypotheses and prove them by further observation or experimentation. Medical cases were adapted from cases developed for medical education, including some from Harvard Medical School.

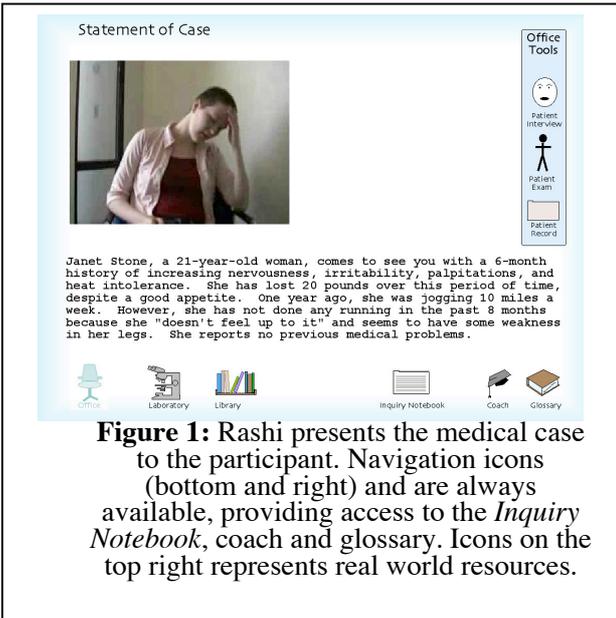
Participants will:

1) See and hear a patient's complaints: nervous symptoms, fatigue, weight loss and sweaty palms.

2) Provide explanations for the problem. An initial hypothesis might be quite vague or the participant might wish to act on intuition or experiential knowledge. Hypotheses will generally require further refinement.

3) Request and gather data, through interviews and medical exams, to confirm or refute each hypothesis. Data recorded may reveal flaws in hypotheses, in which case participants can revise their hypotheses, and change their belief in hypotheses.

4) Write-up their hypotheses, ask the coach for an assessment of their work and make a final submission which involves designating one "best" hypothesis.



The screenshot displays a software interface titled "Statement of Case". It features a central image of a woman (Janet Stone) looking distressed. Below the image is a text block containing a medical case description. To the right of the text is a vertical "Office Tools" menu with icons for "Patient Interview", "Patient Exam", and "Patient Record". At the bottom of the interface is a horizontal navigation bar with icons for "Office", "Laboratory", "Library", "Inquiry Notebook", "Coach", and "Glossary".

Figure 1: Rashi presents the medical case to the participant. Navigation icons (bottom and right) and are always available, providing access to the *Inquiry Notebook*, coach and glossary. Icons on the top right represents real world resources.

Rashi¹, the inquiry tutor, makes several fundamental contributions. It supports inquiry learning through tracking student reasoning. Many computer projects promote inquiry learning. But few actually track, analyze and then comment on the participant's

¹ Rashi was a biblical scholar who introduced inquiry methods in the eleventh century. He wrote extensive commentaries, produced queries, explanations, interpretations and discussions of each phrase and verse of the bible. Rashi's written commentary on the bible made it more comprehensible for everyday scholars. Today, these and other commentaries, assembled in the Talmud, have been extended to nearly 40 volumes and continue as a source of biblical law (Steinsaltz, 1976).

selection of data and creation of hypotheses and inferences. This system tracks participant hypotheses and data discovery and includes coaches to encourage participants to support or refute hypotheses with sufficient evidence. A second innovation is the usability in several domains; we have prototypes in biology, forestry, civil engineering and geology.

Inquiry Notebook and Knowledge Representation.

As each participant moves through the inquiry cycle, the tutor follows her reasoning with an expert representation of the medical case. The participant interviews the patient and records important symptoms, Figures 2-3. She “performs” a medical exam on the patient and identifies salient symptoms and lab results. In particular, the participant isolates those data that support, refute, or have no bearing on a given hypothesis. The participant reads medical source documents and studies the patient’s signs and symptoms.

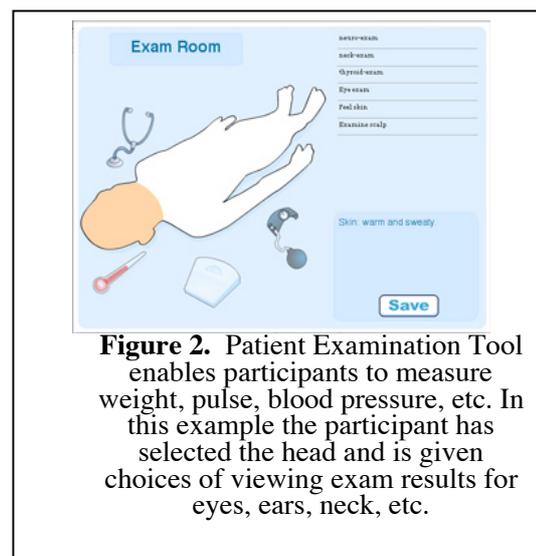


Figure 2. Patient Examination Tool enables participants to measure weight, pulse, blood pressure, etc. In this example the participant has selected the head and is given choices of viewing exam results for eyes, ears, neck, etc.

Rashi provides an *Inquiry Notebook* to collect participant information, Figures 4-5. Once the participant is oriented to the goal of the case and uses data gathering tools and libraries and web sites and textbooks, she is asked to record meaningful units of data or *propositions*. The participant keeps track of where propositions come from (i.e. cites the sources). Participants may indicate relationships between propositions by linking them with *supports/refutes* links, Figure 4, and these relationships become propositions as well. Relationships are often justified by some fact or principle found in a medical source. Finally, these chains of relationships terminate in a proposition (hypothesis).

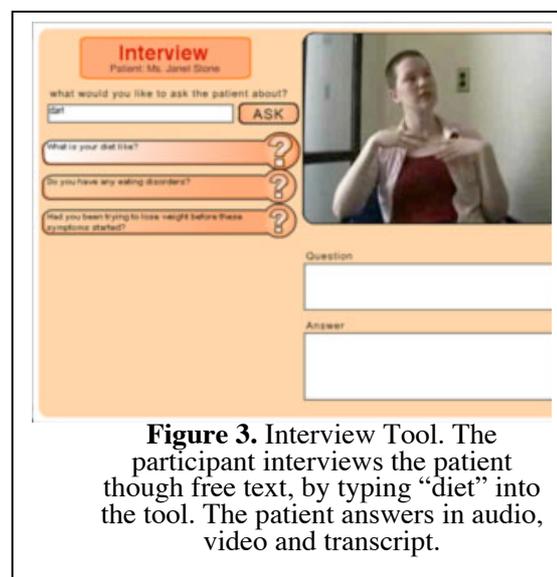


Figure 3. Interview Tool. The participant interviews the patient through free text, by typing “diet” into the tool. The patient answers in audio, video and transcript.

For example, the interview tool can be accessed to find out about the patient’s diet, Figure 3. By examining the patient in a virtual-world exam room, Figures 2 the participant may learn that the patient weighs 100 lbs. By asking what the patient weighed 6 months ago, the participant can examine the patient’s medical records (another virtual-world tool) and find that the patient weighed 135 lbs. A simple deduction may be made that the patient has lost a significant amount of weight despite good eating habits and not much exercise. The participant types the text of this deduction into the *Inquiry Notebook*, and it is automatically added to the list of propositions. Later the participant might come across a source in the library that lists the symptoms of hyperthyroidism. The list includes

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“weight loss despite good appetite” among other things. When the participant clips the article it is inserted into the *Inquiry Notebook*.

The Coach

The *Coach* uses a Bayesian Belief Network (BBN) to analyze the participant’s *Inquiry Notebook* and history of activities and give feedback. For example, the *Syntactic Coach* checks that a node can not support or refute itself (circular logic) and that a participant should list more than one hypothesis. It also checks that factors may not support or refute data/principles and that principles may not support or refute data. The *Semantic Coach* recognizes when a node is correctly used but overly abstract and will suggest that the person further specify the proposition, by perhaps, looking more closely at texts stored in child links of the domain model which contains "permissible," "essential," and "misconception" links between data and factors. If a participant uses links that are not permissible, essential or misconception, then the coach will state that data is irrelevant.

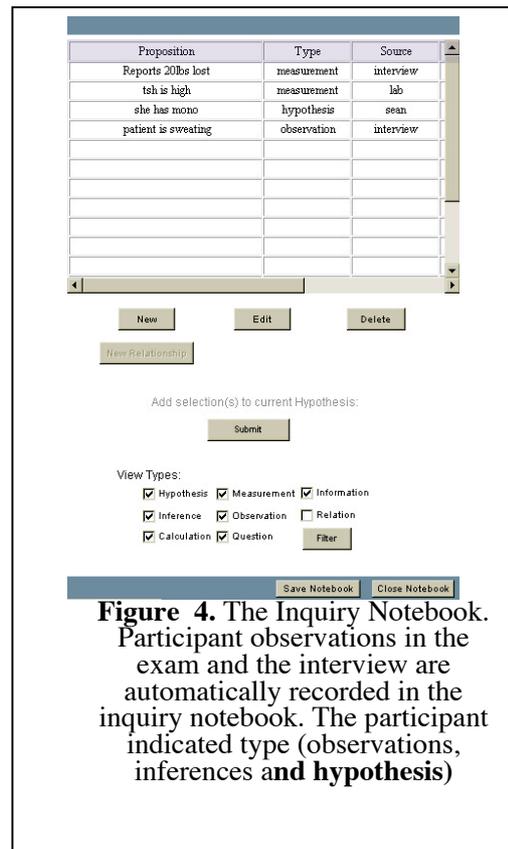


Figure 4. The Inquiry Notebook. Participant observations in the exam and the interview are automatically recorded in the inquiry notebook. The participant indicated type (observations, inferences and hypothesis)

The *Coach* might comment on:

- the *syntactic structure* of the participant’s argument: Does the participant understand the difference between data and hypotheses? Use data to support hypotheses?
- the *semantic content* of the participant’s argument: Are the inferences and conclusions made supported by the data and the medical knowledge?
- the participant’s *knowledge of the process of inquiry* itself: Is the participant’s investigation progressing in a way that could be considered successful inquiry?
- how the above *ideas relate to one another*: Is the participant making appropriate connections among propositions? What is the nature of errors?

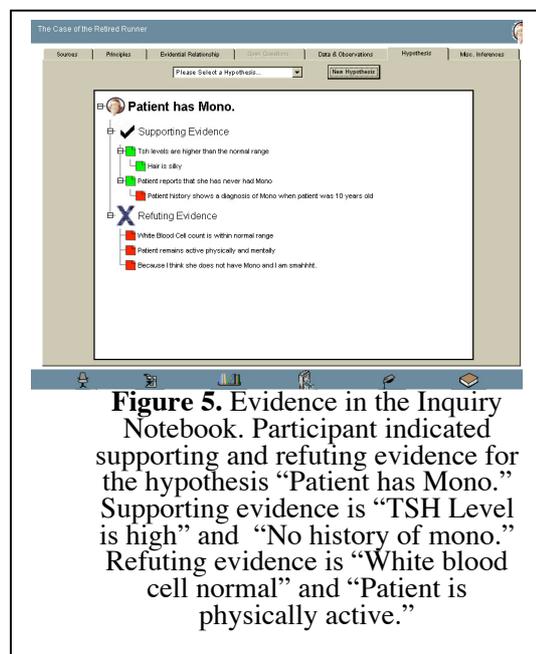


Figure 5. Evidence in the Inquiry Notebook. Participant indicated supporting and refuting evidence for the hypothesis “Patient has Mono.” Supporting evidence is “TSH Level is high” and “No history of mono.” Refuting evidence is “White blood cell normal” and “Patient is physically active.”

Relation to another contribution

This IE is related to a long AI& ED paper entitled: Tracking Participant Propositions in an Inquiry System, Woolf, Marshall, Mattingly, Lewis, Wright, Jellison, Murray