A Demonstration of ITTs That Promote Scientific Inquiry Skills: Critical Thinking Tutor and ARIES

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Abstract. We will demonstrate two Intelligent Tutoring Systems (ITs) that aspire to teach scientific inquiry skills through a natural language conversational dialogue. The ITs include a new version of the AutoTutor system called Critical Thinking Tutor and ARIES (Acquiring Research Investigative and Evaluative Skills), which is a semester-long tutorial intervention that teaches scientific inquiry skills via a trialogue between two animated pedagogical agents (APAs) and a human learner. The systems provide cases that mirror authentic scientific research and allow users to evaluate the studies by assuming various roles (student, teacher, judge, jury), posing questions, and offering critiques.

Introduction

Scientific inquiry or the ability to comprehend and critique scientific research is lacking in most Americans. However, it is a crucial skill for the general public because people are incessantly exposed to spurious research on the Internet, TV, and print. Scientific inquiry involves skills related to designing and evaluating experiments, such as stating hypotheses, identifying dependent and independent variables, isolating potential confounds in designs, interpreting trends in data, determining if data support predictions, and understanding effect sizes. The ability to evaluate a piece of research on the basis of scientific validity (conclusion, construct, internal, and external) and the capability to ask critical questions lies at the heart of scientific inquiry skills. However, students rarely ask deep reasoning questions. Instead they settle for shallow facts and cursory ideas. Therefore, an innovative approach is needed to develop learners that can move beyond surface knowledge and shallow thinking and become conceptual thinkers, problem solvers, and scientific skeptics.

We have developed two ITs that that aspire to promote scientific inquiry skills, in collaboration with researchers at University of Illinois and Claremont –
McCenna College. The ITSs, Critical Thinking Tutor and ARIES, will be demonstrated in the session.

**Critical Thinking Tutor**

The Critical Thinking Tutor is a new version of the AutoTutor that aspires to teach scientific inquiry skills to students. AutoTutor is an intelligent tutoring system that helps students learn Newtonian physics and computer literacy through tutorial dialogue in natural language (Graesser, et al., 2001). AutoTutor’s dialogues are organized around difficult questions and problems that require reasoning and explanations in the answers. AutoTutor engages the student in a mixed-initiative dialogue that draws out more of what the student knows and that assists the student in the construction of an improved answer. AutoTutor provides feedback to the student on what the student types in (positive, neutral, negative feedback), prompts the student for more information (“What else?”), prompts the student to fill in missing words, gives hints, fills in missing information with assertions, identifies and corrects misconceptions and erroneous ideas, answers the student’s questions, and summarizes topics.

We have adapted AutoTutor to teach Critical Thinking Skills by posing cases that mirror authentic scientific research and allowing students to evaluate the studies by posing questions and offering critiques via a natural language dialogue. The effectiveness of the Critical Thinking Tutor has been evaluated in a study comparing the tutor to a read textbook and no intervention control. The tutorial intervention significantly outperformed both controls (Storey, et al., in review).

**ARIES: Acquiring Research Investigative and Evaluative Skills**

The ARIES tutor teaches scientific inquiry via a trialogue between two animated pedagogical agents (APAs) and a human learner. The two agents can assume a variety of roles depending on the scenario or problem is being presented. Some example roles include fellow students (a peer learner), a judge listening to an appeal (a knowledgeable agent), a neighbor discussing a type of plant food (a less knowledgeable agent), or a scientist presenting his or her work (an expert agent).

ARIES is a major extension of the Critical Thinking Tutor. It supports a semester long training period, embodies elements of serious games, and advocates knowledge transfer. Well established principles form the pedagogical and motivational foundation of ARIES. These include principles of self-explanation, active learning, vicarious learning, reciprocal teaching, feedback, and case-based learning.
Technical Content of Demonstration

This session will include a live demonstration of the Critical Thinking Tutor and ARIES. An alpha version of the Critical Thinking Tutor that supports full interaction will be used for the demo. Users will be able to interact with the Critical Thinking Tutor. ARIES is a much more complicated ITS and is still in the early development stage. Hence, the demonstration will utilize an early prototype of the system.

A demonstration session with the Critical Thinking Tutor would involve the tutor providing a research scenario and asking the user to evaluate the study. The user would then engage in a mixed initiative dialogue with the tutor. An example scenario is listed below.

I knew it was true. Women are more aggressive than men. I read a study that asked twenty women and twenty men to rate how angry they feel. They rated their feelings on a five point scale from not at all angry to very angry. The study found that on average women felt angrier than men. So, you see it is a complete myth that men act more aggressively than women.

Perhaps, let’s get another opinion. Please describe and explain to me any problems you may see with the experiment, findings, or interpretation. If there are no problems, type good experiment.

Hardware and Software Requirements

Both systems run on the authors’ laptops. We would need a desk for the laptop, a power outlet, and a connection to the network.

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