

BROCA: A Computer-Mediated Learning Tool for Teaching Scientific Reasoning and Writing

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This "work-in-progress" describes a computerized learning environment for teaching the conceptual patterns of scientific reasoning. BROCA (Basic Research, Observations, Critical Analysis) is theory-driven, combining two very powerful conceptual models of thinking. The first -- drawn from cognitive psychology and information theory -- focuses on the mental manipulations by which data becomes information and information becomes knowledge. The second theoretical construct comes from rhetoric and describes the intellectual activities carried out in prewriting, drafting, and revision by an expert writing. As an interactive "cognitive tool," BROCA provides scaffolding (through visual algorithms and adaptive prompting) to help a fledgling thinker practice the robust patterns of scientific reasoning.

BROCA is a multimedia, interactive learning environment that wedds forms of scientific inquiry to forms of scientific discourse. Through a series of computer-mediated "thinking frames," BROCA serves as an end-to-end knowledge development environment that mediates the intellectual activities implicit in scientific thinking. In broad terms, the process of scientific inquiry mirrors the writing process. Both the scientist and the writer go through an initial gathering and sorting out of ideas, from which tenuous -- though testable -- explanatory notions are made (hypotheses for the scientist and thesis statements for the writer). After considerable trials, sound relationships between entities are found (experimentation for the scientist and drafting for the writer) and a supportable belief structure emerges. Continued scrutiny (replication in science and revision in writing) results in knowledge -- an artifact that can take its place in the body of received opinion. *Because of this similarity of intellectual activities, writing can be used as an analog for scientific thinking.*

BROCA uses Bereiter & Scardamalia's [The Psychology of Written Composition, 1987] notion of a dual problem-space model for writing: a content space (essentially, summarizing, analyzing, and synthesizing information about the topic) and a rhetoric space (essentially, planning and organizing the domain information into a logically and stylistically appropriate formal text artifact). Six distinct cognition enhancers work in tandem to mediate the multi-staged process.

Like an adult version of "turtle logic," BROCA tokenizes mental manipulations and places the resultant visualizations in a constrained context so as to model the elaborations, state transitions, and reconfigurations of knowledge structures taking place in the problem spaces. Users interact with the computerized environment in rich but highly defined ways. The microworld mediates thinking by making choices explicit, by helping to manage the cognitive load, and by encouraging reflection during the thinking/writing process. In short, BROCA instantiates a "visual nomenclature" for reasoning whose components becomes synoptic overviews that trigger sophisticated intellectual activities such as formulating inferences about relationships, evoking strategies to facilitate thinking, and prompting metacognition, or self-regulation for deploying, adapting, or abandoning sets and subsets of strategies based on awareness of the situation.

Commercial packages offering the writer a collection of tools (such as the analysis routines in the Writer's Workbench) have been around for some time now. Nevertheless, it is important to recognize that these tools are separate entities. While the writer is free to pick and choose among them, the tools are not integrated nor are they supported by AI interpreters. In other words, work done with one tool does not translate seamlessly to the "world" of another tool. At a minimum, this is inconvenient. More telling for a worker or a learner, gains in one stage of composing are not easily consolidated and carried forward to the next stage. In fact, the welter of detail generated by some tools or heuristic routines may constitute a step backwards because the writer has to deal with (1) the cognitive overload of multiple versions or even contradictory instances of the same thoughts and (2) a potentially recurrent dis-integration of thoughts constructed while working with different tools or heuristic devices.