

	Summary	Tutor allows			Strategy Taught	Reification			Help	Lessons Learned
		False input	Illogical leap	Redundant assertion		Operator	Operator Application	Goal Structure		
Ms. Lindquist <a href="#">Heffernan (2001)</a>	Symbolization of word problem	No?	No?	No? (strict MTT?)	?	-	-	-	8 tutorial questions,  4 tutorial strategies	Better than traditional CAI
CMU Proof Tutor <a href="#">Scheines (1994)</a>	Formal logic. The scale of the domain is not reported.	Yes	No	Yes	FC, BC, bidirectional	-	Conventional proof display shows premises and conclusions	Fitch diagram & Goal tree	"Strategic hint" -- hints on backward reasoning.	Bidirectional wins. The strategic help affects performance on hard problems.
Angle <a href="#">Koedinger (1993)</a>	8 rules in execution space and 4 diagrammatic schemas.	No (only true instantiations are available)	Yes	Yes	Separation planning prior to execution.  FC only "previous GPT show that students tend to ignore BC hint. (Dissertation 1991, p.39)" but recent version seems to work BC?	Iconic representation	Iconic representation of legal instantiations (diagram parsing) and application (schema justification)	Goal tree (part - statement justification)	"Strategic hints" -- hints on schema selection, part-statement justification, and schema justification	Angle and GPT tied in overall post-test.  Angle superior in planning (DS application), but students rarely completed planning before execution (p.38).  Carrying execution early scored better on post-test.

Exploratory GIL <a href="#">Reiser (1994)</a>	Exploratory group: fixed set of problems. Must solve all.  Free group: no problems provided	Yes	Yes	Yes	-	Same as GIL ↓↓↓	Same as GIL ↓↓↓	Same as GIL ↓↓↓	Same hints as GIL, but on student's demand	Time - achievement trade off. Exploratory group gained more debugging skill
GIL <a href="#">Reiser (1992)</a>	90 FC rules 90, BC rules , and 15 plans	No (Legal errors get immediate feedback)	No (Operator application must use elements shown in the solution tree)	No (Strategic errors get immediate feedback. Still can't resolve the <i>ambiguity problem</i> )	Bidirectional but implicit (tutor suggests subgoals to achieve or a legal forward step, a forward step that achieves a goal )  Heuristics for operator selection	Iconic	drop an operator icon and connect it to either input or output, then specify the other end of data flow	Goal tree	next step hint suggests a step recommended by problem solver.	No experiment reported.
Related Rates Tutor <a href="#">Singley (1990)</a>	32 problems with 7 arithmetic operators decorated by 8 cover stories	No (two trials followed negative feedback)	No	No (no higher-order differentiation. Apply operator once. No regression from a neighborhood of the goal )	Guide on strict BC	Listed as a menu	Embedded in the goal tree	Goal tree	Show next optimal operator application	Goal reification expedite learning, but the effect size is quite small

The ambiguity problem: Even when the tutor restricts the student to apply only operators that are on the solution path, there might be several alternatives available. Hence the tutor can not always determine the student's plan given an operator application. Furthermore, an operator application that is once accepted as a legal application might turn redundant (or inappropriate) later when the student applies a conflicting operator. (Reiser, 1992, p.133)