

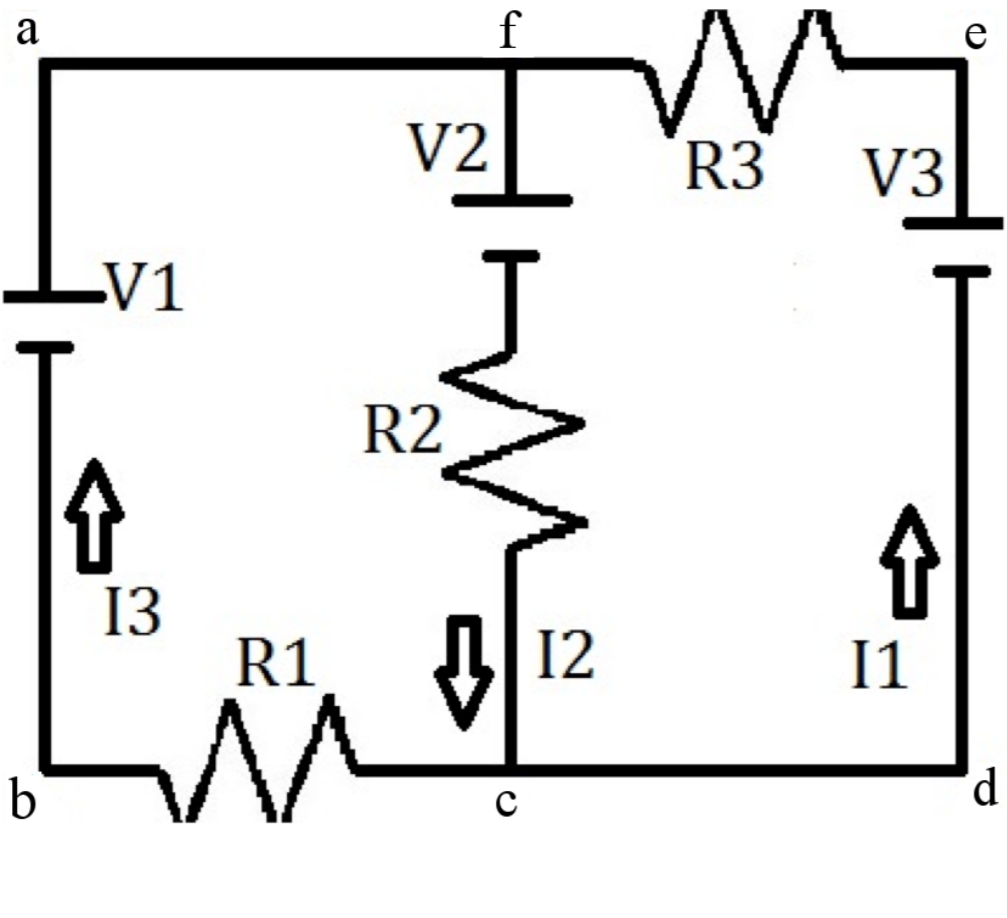
Engaging Higher Order Thinking Skills with a Personalized Physics Tutoring System

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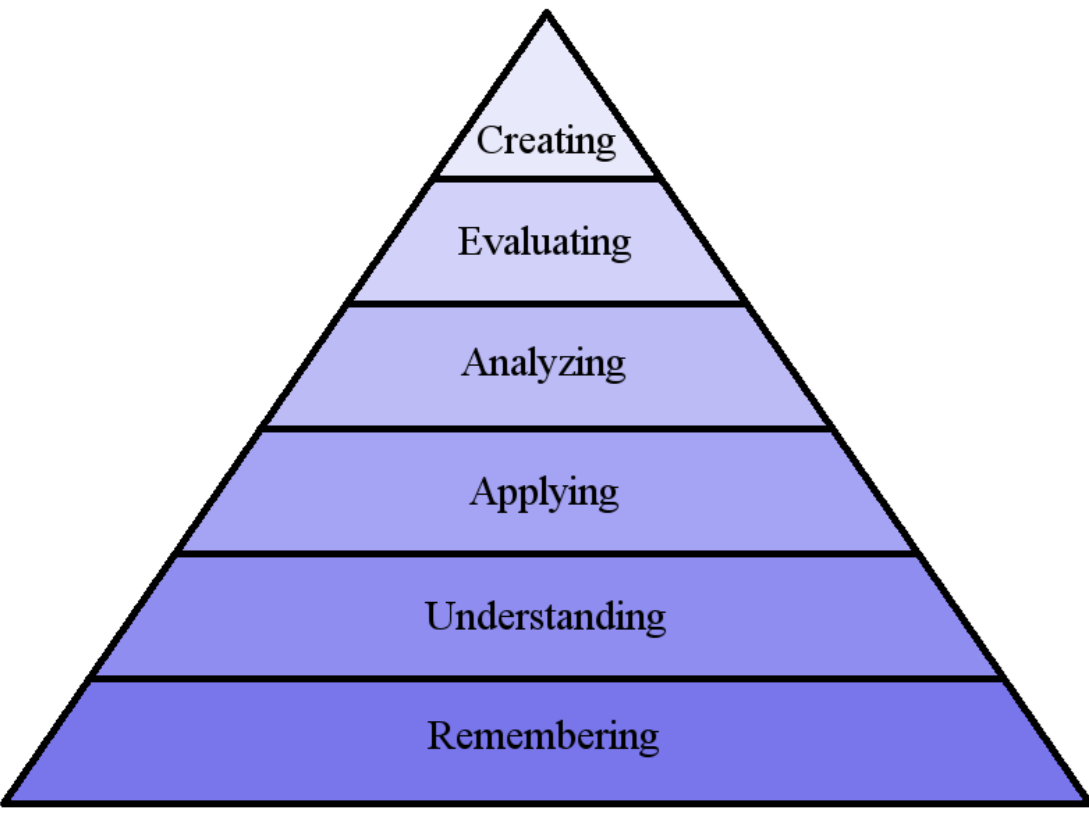
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Research Goals

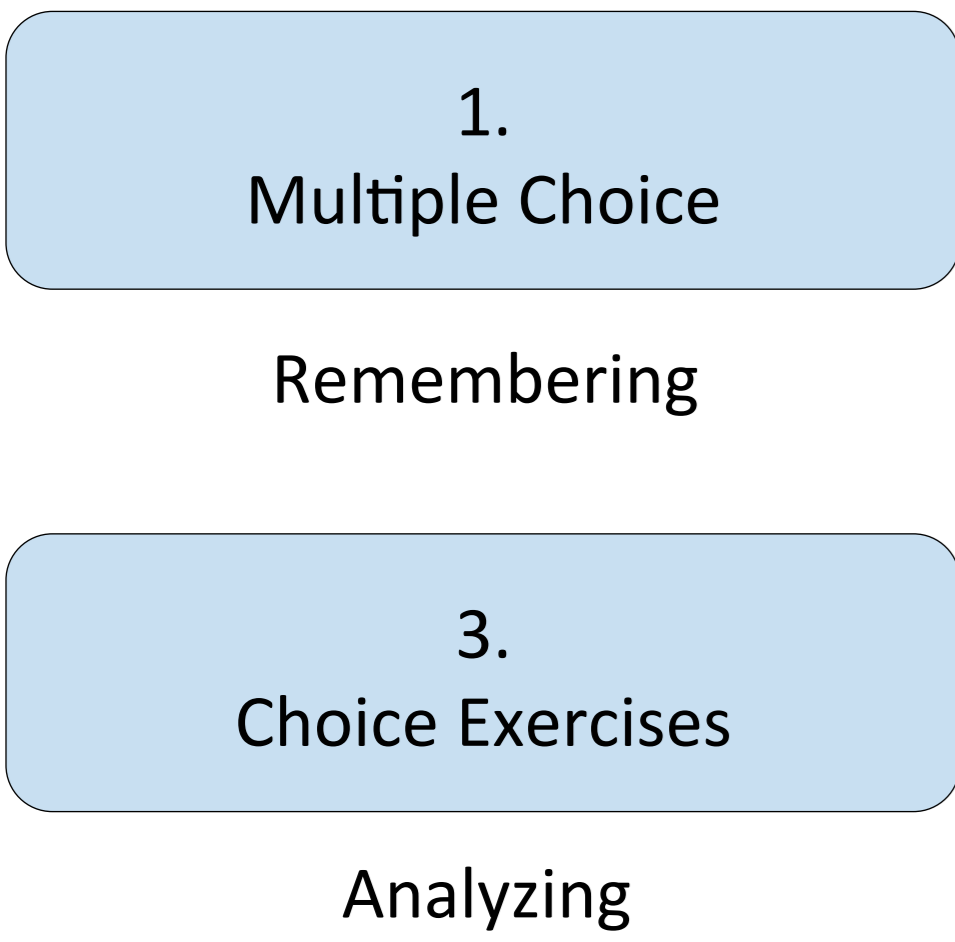
- Identify student weaknesses
- Offer individualized help
- Increase student confidence, engagement and performance in Physics, specifically Kirchhoff's Rules



Pedagogical Design

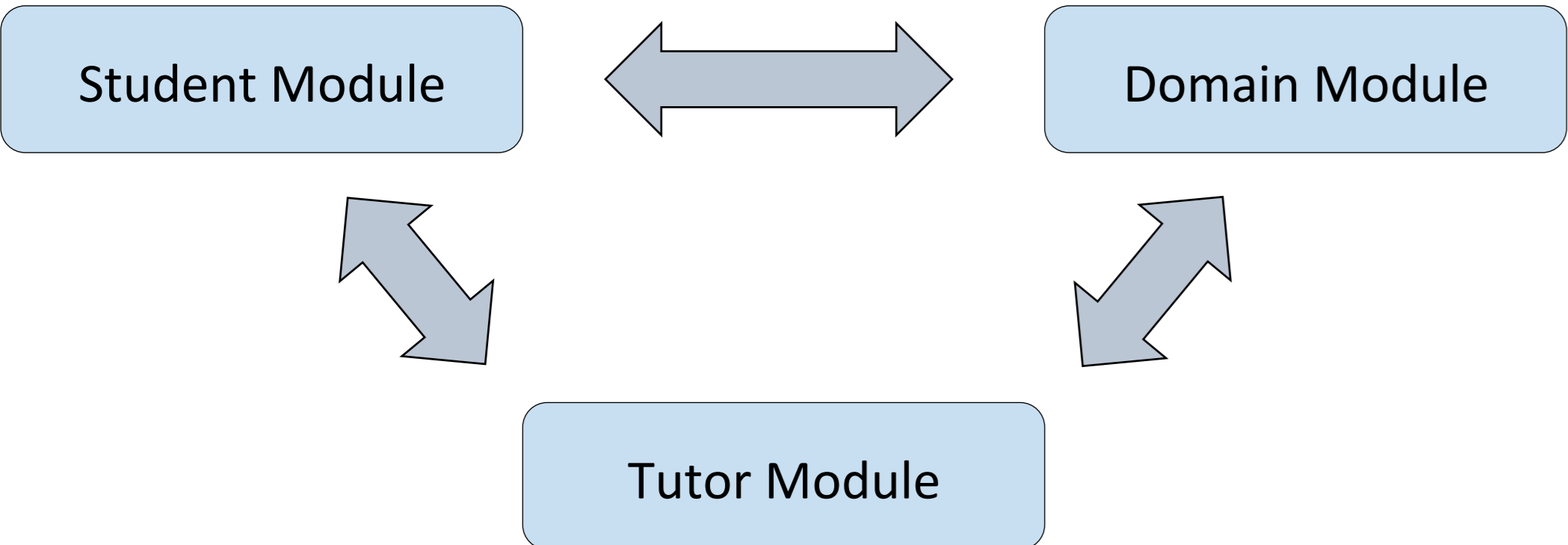


- Four modes design based on Bloom's Taxonomy
- Advanced modes designed to elicit higher order thinking skills
- Each mode involves exercises with three levels of difficulty
- Users placed into most appropriate mode, but has control to opt out



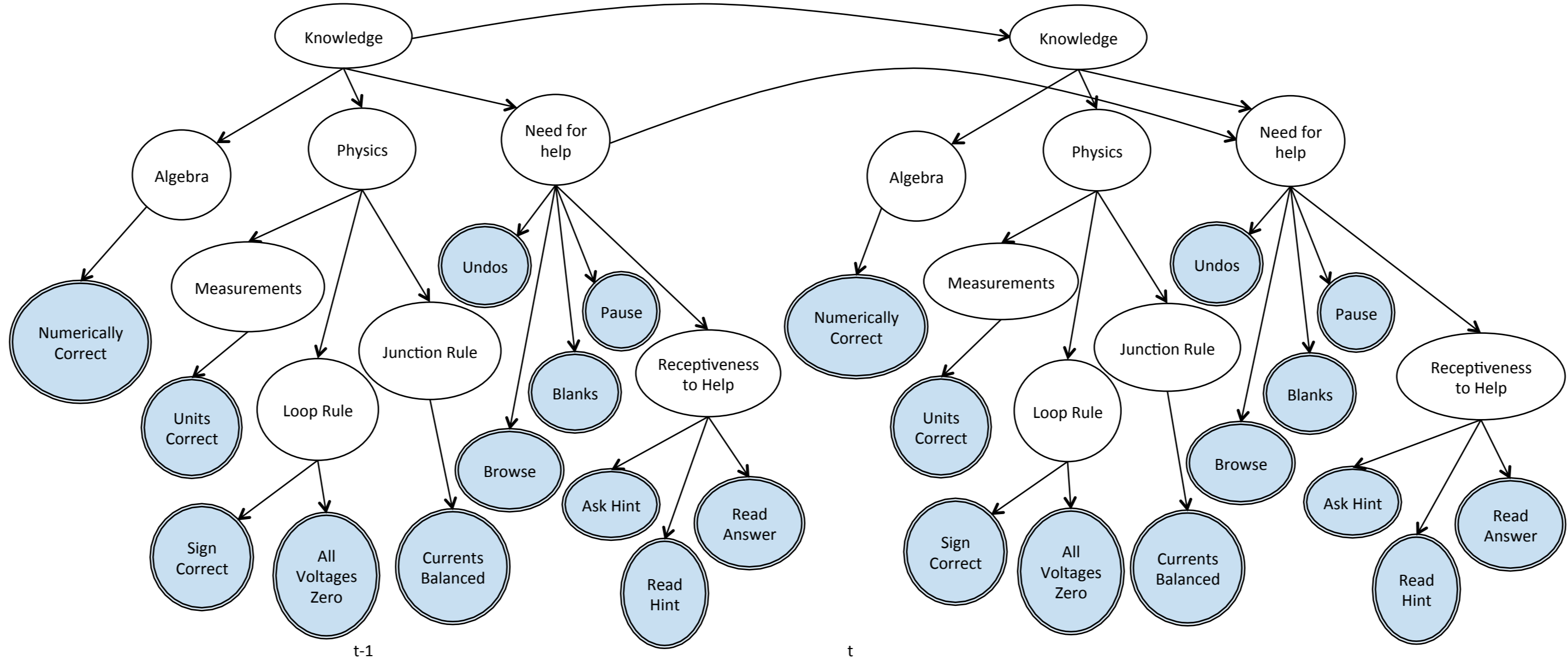
System Architecture

- Designed with 3 modules:
 - Domain – Physics content, solution graphs
 - Student – User knowledge and attitude, behavioural observations
 - Tutor – Expected utility calculations for best action



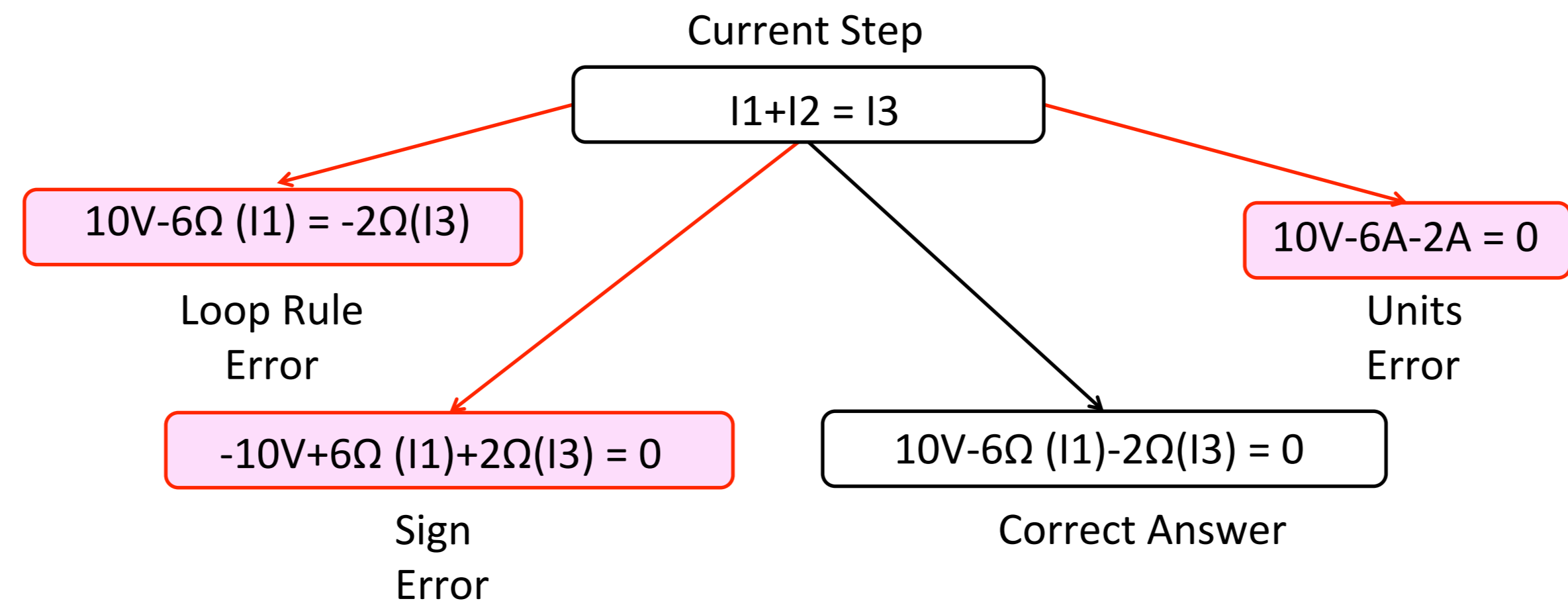
Student Module

- Formalized as a dynamic Bayesian network
- Models student mastery as well as attitudes
- Applies clique inference to estimate $\Pr(\text{Knowledge}_t)$ and $\Pr(\text{Neediness}_t)$



Domain Module

- Encodes Physics problems as solution graphs
- Checks student answers to identify types of mistakes present



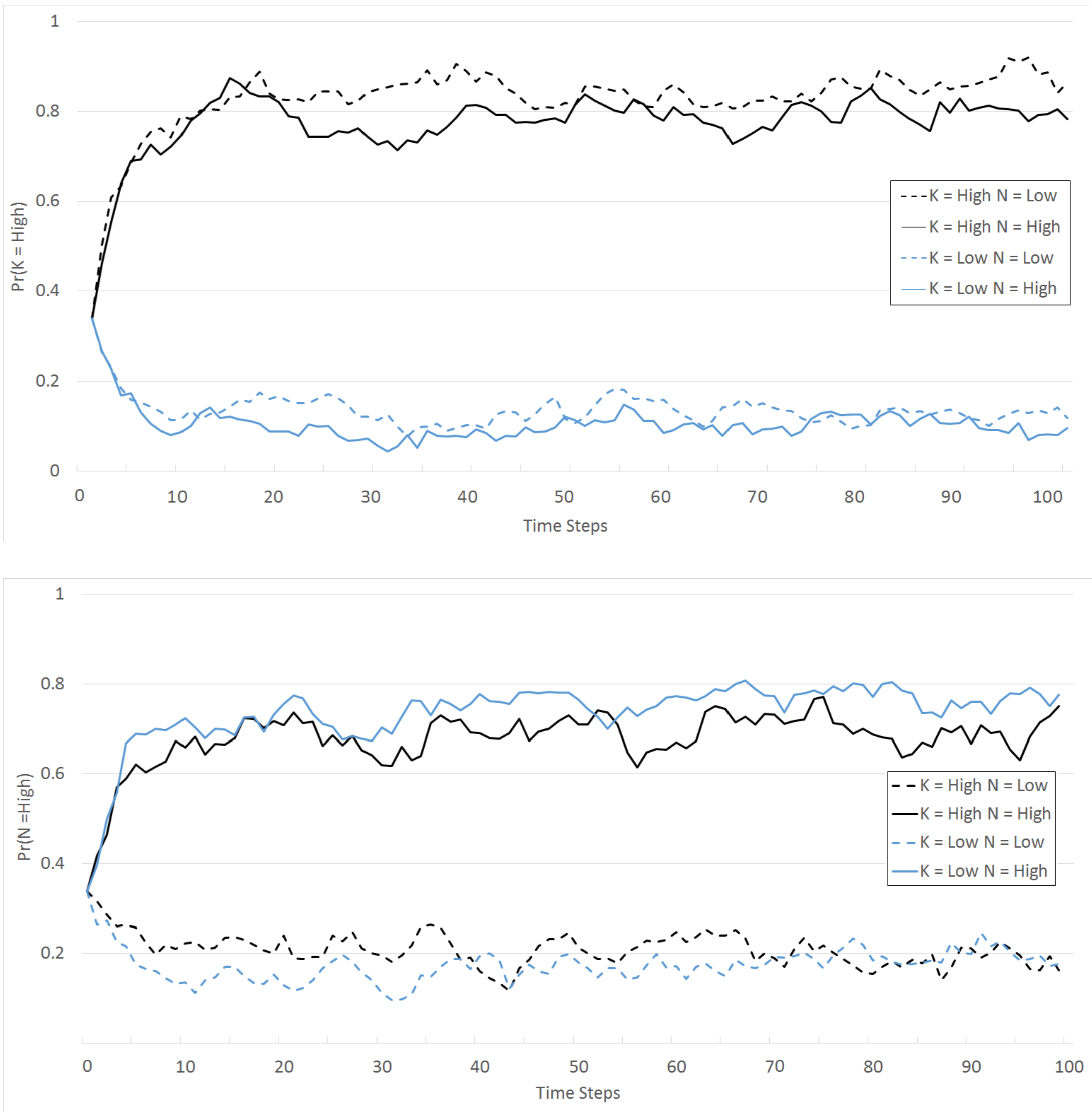
Tutor Module

- Uses information from other modules to find how to help
- Chooses from 3 possible actions:
 - Offer context-sensitive hint
 - Offer full explanation
 - Do nothing
- Uses maximum expected utility to make decisions

$$EU(A) = \sum_S P(S) \times R(A, S)$$

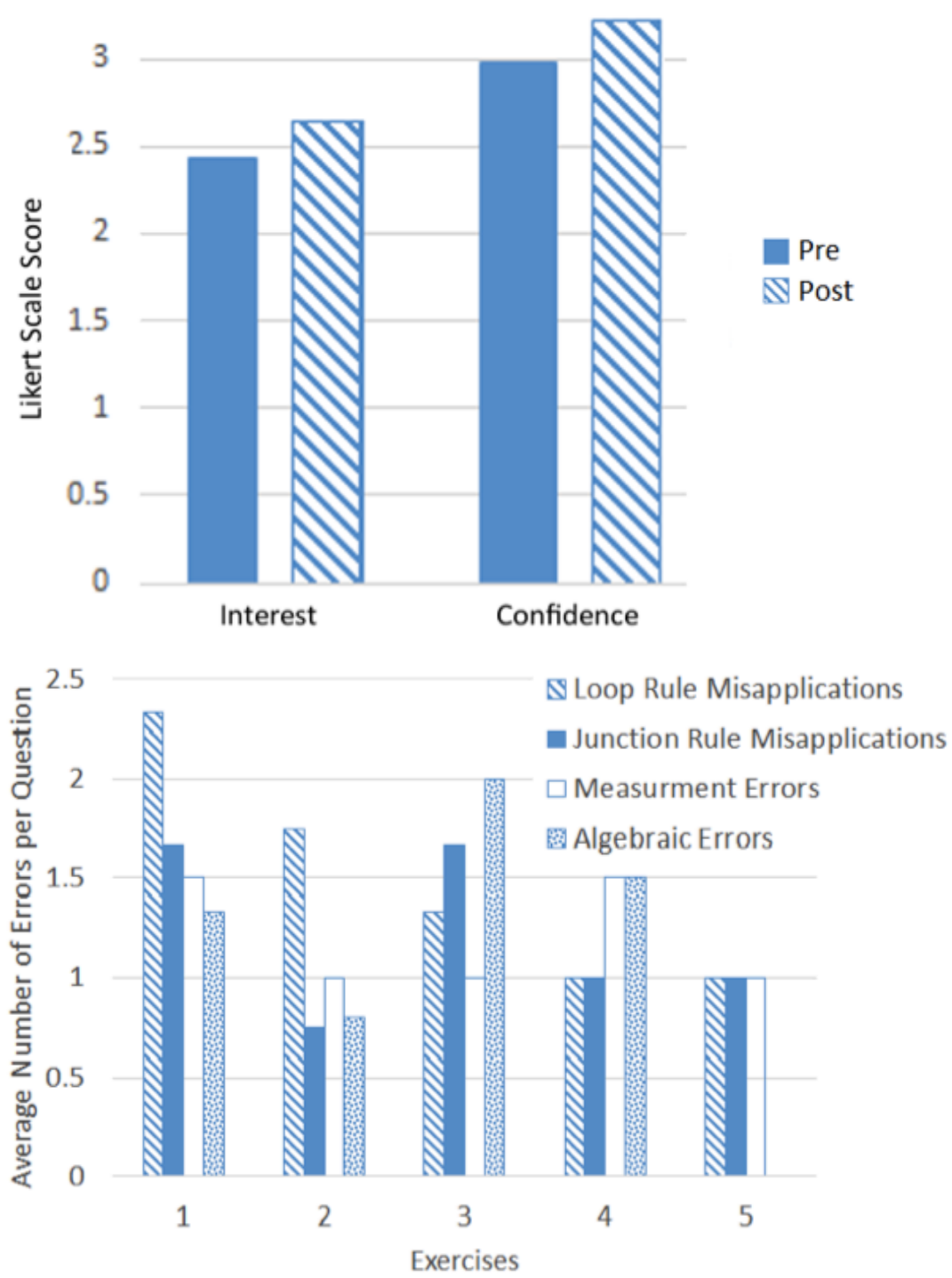
Simulation

- Tested ability to support different student types



Pilot Study

- Tested with students enrolled in summer offering of PHYS 122
- Showed increase in student interest and confidence
- Knowledge gains: more practice leads to fewer mistakes



Acknowledgements

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a place of mind
THE UNIVERSITY OF BRITISH COLUMBIA