Computer Problem-Solving Coaches

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Theoretical framework

- Cognitive apprenticeship
  - Curricular efforts to improve students' problem-solving skills are all based (explicitly or implicitly) on this.
  - Components: Modeling, Coaching, Fading
  - Examples: craft apprentices, athletes, graduate students

Computers as coaches

- In an introductory physics class, the time available for students to practice solving problems in an environment where they can receive guidance and feedback is severely limited!
- Well-constructed computer programs can provide students with 24/7 coaching.

Functions of the computer

- Make explicit the expert’s tacit knowledge, break down the expert’s compiled knowledge
- Model expert-like problem-solving behavior, provide students with coaching, withdraw assistance as student learns

Making thinking visible

Minnesota problem solving framework

1. Focus the problem
   - Draw a picture incl. given information
   - Determine question to be answered
   - Determine approach to use
2. Describe the physics
   - Draw diagrams and define physical quantities
   - Determine target quantities
   - Write down quantitative relationships
3. Plan the solution
   - Select an equation containing the target quantity
   - Identify other unknowns in equation
   - Solve a sub-problem to find each unknown
   - Check units of result
4. Execute the plan
   - Calculate value of target quantity
5. Evaluate the answer
   - Check if answer is properly stated
   - Check if answer is unreasonable
   - Check if answer is complete

Draw a picture

- important objects
- perspective

kinematics quantities

- position
- velocity
- acceleration
- time

dynamics quantities

- force

- other parameters

Computer coaching

- Help students use expert-like framework to solve problems, providing individualized guidance and feedback
- Model and coach cognitive functions: deciding, implementing, assessing
- Vary assistance according to students' skill level

Instructional strategies

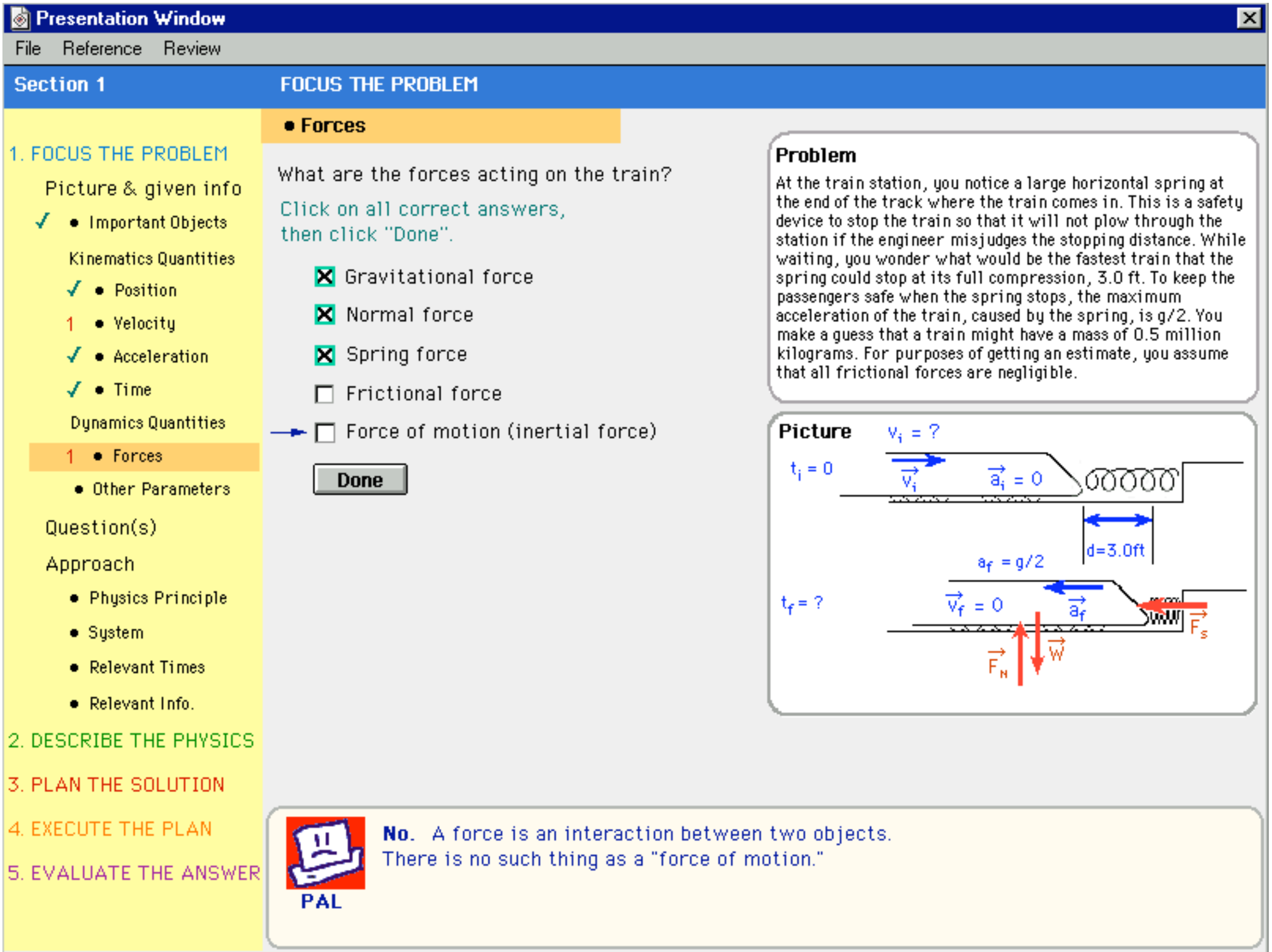
- Reciprocal teaching
  - Implementation mode:

    Computer decides, student implements, computer assesses
  - Coaching mode:

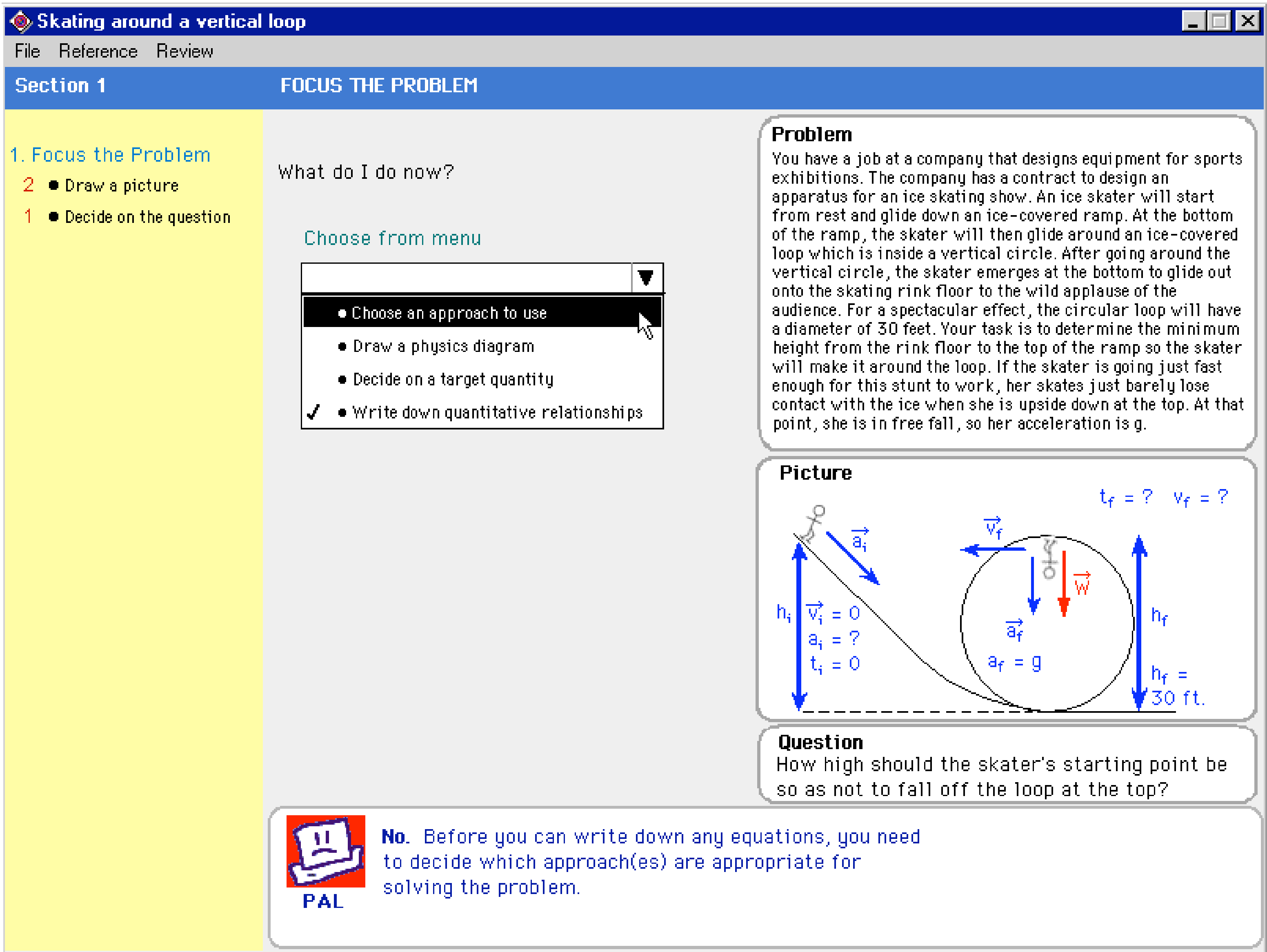
    Student decides, computer implements, student assesses
- Learning from well-studied examples
  - Performance mode:

    Student solves problem with minimal assistance

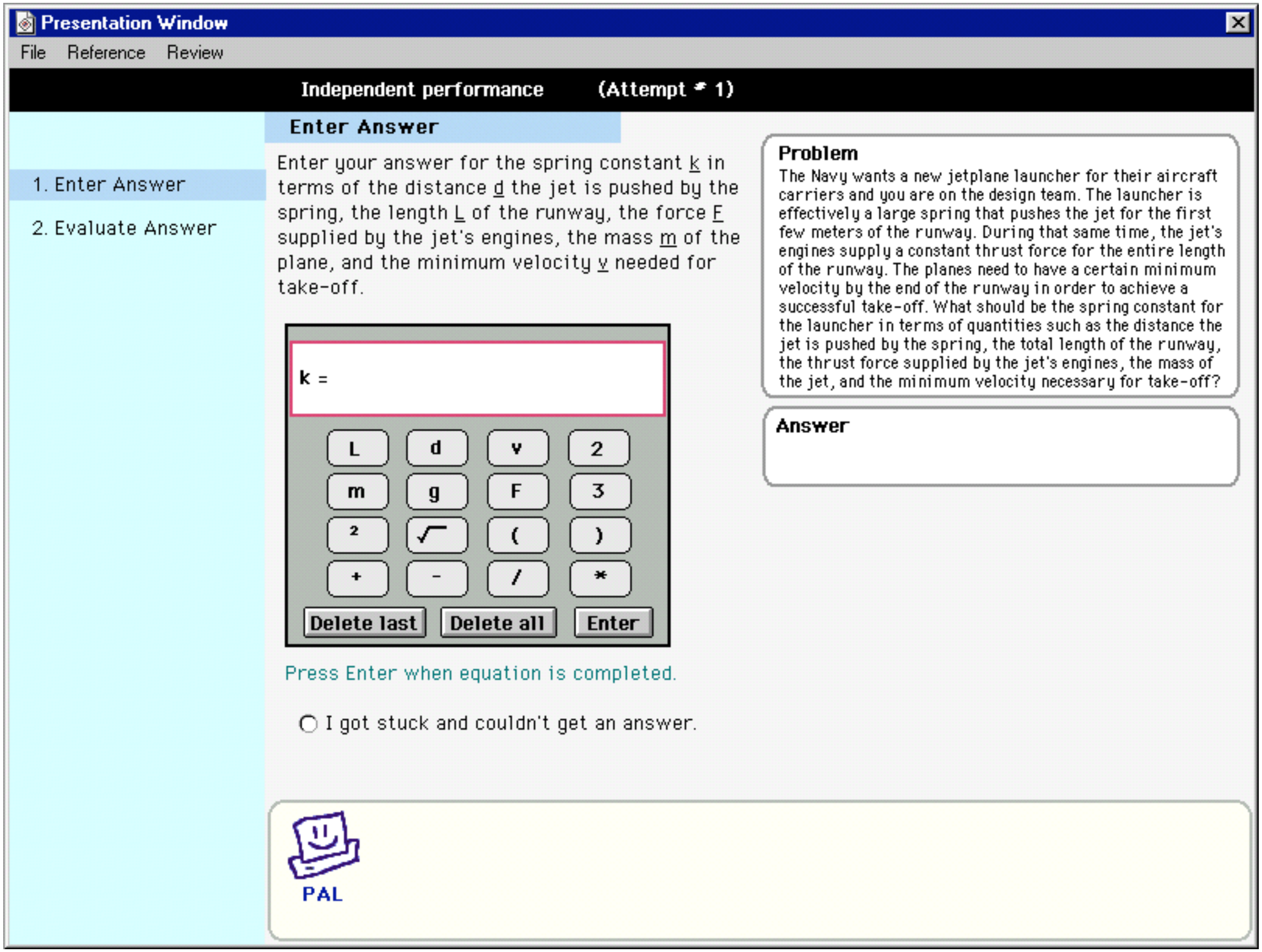
Implementation mode



Coaching mode



Performance mode



Assessing the coaches

- Prototype usability
  - Test coaches with a small number of student volunteers
- Educational efficacy
  - Small-scale pilot study
  - Quasi-experimental study for educational impact

Pilot Study

- Two groups of student volunteers
  - Groups matched according to previous exam scores
  - Group 1: Computer coaches
  - Group 2: No computer coaches
- Compare performance on subsequent exam
  - Problem-solving success
  - Use of expert-like framework
  - Assessment behaviors
- Interview students and examine log files for ideas on possible improvements

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