Facilitating Students’ Transfer of Problem Solving Skills Across Representations in Teaching/Learning Interviews

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1. QUESTIONS
- What kinds of difficulties do students have when transferring their problem solving skills across different representations?
- How do the difficulties depend upon the sequence in which problems are presented?
- How do these changes affect students’ progress through the semester?

2. LITERATURE REVIEW
- Van Heuvelen developed strategies to facilitate students’ problem solving across representations [1].
- Meltzer found a dependence of students’ performance on representational form [2].
- Kohl and Finkelstein found that students’ prefer pictorial representation, but this does not necessarily make them more successful in problem solving [3].

3. METHODOLOGY
- Individual Teaching/Learning Interviews
  - Calculus-based physics volunteers (N = 20)
  - Each participant was interviewed four times during the semester.
  - Each interview came after an in-class exam.
  - During each interview, the student were:
    - Asked to solve three problems:
      - Original problem: a problem from their most recent exam
      - Graphical problem: part of the information was given as a graph
      - Functional problem: part of the information was given as a function
    - Asked to think aloud while solving problems.
    - Given verbal hints whenever unable to proceed.

4. EXAMPLE OF INTERVIEW PROBLEMS
- A hoop radius \( r = 1 \) cm, and mass \( m = 2 \) kg is rolling at an initial speed \( v = 10 \) m/s along a track as shown. It hits a curved section (radius \( R = 3.0 \) m) and is launched vertically at point A.

5. RESULTS
- For this poster, we present data from students in interview 2 and interview 4.

5. RESULTS Cont’d
- Categories of Difficulties
  - PRINCIPLE: inappropriate use of physical principles
  - QUANTITY: incorrect use, calculations, and units of physical quantities
  - FORMULA: incorrectly recall a formula or interpret meaning of formulae/expressions
  - VALUE: uses incorrect value of physical quantities
  - MATH: unable to manipulate mathematical processes
  - GRAPH: unable to process information from the graph provided
  - FUNCTION: inappropriate interpretation or use of the function given
  - CALCULATION: simple calculation errors

- Categories of Hints
  - PRINCIPLE: enables students to determine the appropriate principle to use
  - INFO: asks students to take a more careful look at the problem statement to gather necessary data
  - QUANTITY: enables students to decide which quantities are applicable in each situation
  - FORMULA: helps students understand the meaning of a formula or an equation
  - MATH: helps students to read off and process information from the graph provided
  - GRAPH: helps students recognize and correct simple calculation errors

- Sequencing Effect
  - In G-F sequence: most difficulties with graph (Fig. 4)
  - In F-G sequence: minor difficulty with function (Fig. 5)
  - Students’ transfer occurs more easily in the F-G sequence than in the G-F sequence.

- Trends Across Interviews
- As students progressed from interview 2 to interview 4 (Figs. 4 and 6)
  - difficulties with graphs and functions decreased dramatically: students had become more capable with graphical and functional representations.
  - difficulties with quantities increased significantly due to the increase in complexity of the problems.

REFERENCES