Investigating Students' Transfer of Problem Solving Skills in Physics Across Multiple Representations

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Motivation

Gain insights into…

- the processes by which students' transfer their…
  - problem solving skills across multiple representations in physics
  - mathematical knowledge and skills to physics problems.
- the ways in which we can facilitate these transfer processes.

Research Questions

- RQ1: What kinds of barriers do students encounter when transferring their problem solving skills across multiple representations?
- RQ2: What kinds of scaffolding are useful in facilitating students to transfer their problem solving skills across multiple representations?
  - In what ways does the sequence in which representational scaffolding is presented affect students' ability to transfer their problem solving skills?

Theoretical Perspective

Vygotsky's (1978) Zone of Proximal Development (ZPD)

- ZPD is the distance between what learners can accomplish by themselves and what they can accomplish with assistance (scaffolding) from another more experienced individual.

Beyond Students' ZPD

Students' ZPD
(Problems they solve with assistance)

Students' Zone of Capabilities
(Problems they solve without assistance)

↕ Scaffolding provided to learner in form of verbal hints and Socratic dialog

Research Context

- Undergraduate Engineering majors at K-State
- Longitudinally follow students …
  - from calculus course sequence
  - to calculus-based physics course sequence.

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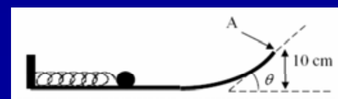
Methodology

- Individual Teaching/Learning Interviews (N=20)
  - Students solved problems in different sequences of representations.
  - Scaffolding (hints, questions) provided when difficulties encountered.
  - Data analyzed to gauge effectiveness of scaffolding to facilitate transfer.
- Ongoing: Develop appropriately sequenced problems to facilitate transfer.

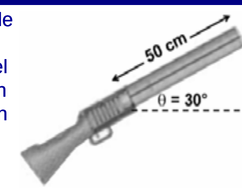
A spring of stiffness constant 3.0 kN/m is compressed a distance of 1.5 cm and a small ball is placed in front of it. The spring is then released and the small ball, mass 0.1 kg, is fired along the slope and launched into the air at point A which is 10 cm above the spring. The angle θ of the velocity at launch is 30°. Friction is negligible.



What is the speed of the ball at launch point A?

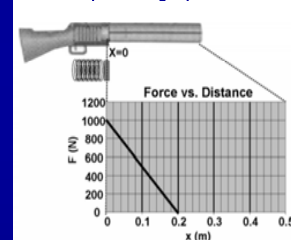
First Problem (Verbal)

A 0.1 kg bullet is loaded into a gun (muzzle length 50 cm) compressing a spring. The gun is fired at a 30° angle. The barrel of the gun is frictionless and when the gun is horizontal the net force, F(N) exerted on a bullet by the spring as the bullet leaves the fully compressed spring varies as a function of its position x(m) in the barrel …



Graphical

… as per the graph below.



Equation

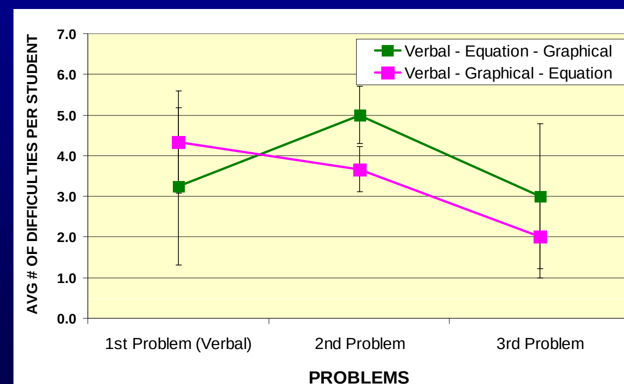
… as per the equation below.

$$F(x) = 1000x + 3000x^2$$

What is the speed of the bullet as it leaves the gun?

Some Early Results

- After verbal problem, fewer difficulties on graphical problem compared to equation problem (α = 0.1 significance).
- Solving the graphical problem before the equation problem decreased the difficulties in solving the equation problem (α = 0.1 significance), but converse not true.



Level of scaffolding needed changes with sequencing of representations.