Assessing Case Reuse Strategies Using Non-Traditional Physics Problems

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Outline

I. Treatment
   I. Group Learning Interviews

II. Assessment
   I. In-class examinations

Assessment Research Questions

- To what extent does the treatment facilitate solving non-traditional problems?
  - [1]Text-editing
  - [2]Problem Posing
  - [3]Jeopardy

[1](Low & Over, 1989) [2](Mestre, 2002) [3](Van Heuvelen, 1999)

Non-Traditional Problems

Text-Editing

Low & Over (1990)
- 'Task requires an understanding of problem structure'
- 'Text editing can be a measure of schematic knowledge'

Problem Posing

Mestre (2002)
- 'Probing students' understanding of physics concepts'
- 'Ability to transfer their knowledge to novel contexts'

Physics Jeopardy

Van Heuvelen (1998)
- 'Effort to represent a physical process in a variety of ways'

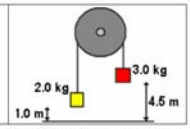
Non-Traditional Problems

Text Editing

Students given problem statement, asked to find irrelevant information

You are given a problem below.

A 2.0 kg mass initially 1.0 m above the ground is attached to thin cord that passes over a frictionless pulley to a second 3.0 kg mass which is initially 4.5 m above the ground. Both masses are initially at rest. Find the final velocity of the 3.0 kg mass right before it hits the ground.



In the problem statement above, specify which, if any, of the following quantities are ***not*** relevant for solving the problem.

(a) 2.0 kg mass (b) 3.0 kg mass (c) 4.5 meters (d) 1.0 meters

(e) None of the above. You need all the information given to solve the problem.

Non-Traditional Problems

Physics Jeopardy

Students given fragment of solution to a problem, asked to identify scenario that corresponds to solution.

You are given below a worked-out solution to a kinematics problem.

Step 1: $x = x_0 + v_{x0}t$

Substituting known values, we get:

$90.0m = 0 + (26.0m/s)t$

Solving for 't'

$t = 3.46s$

Step 2: $y = y_0 + v_{y0}t + \frac{1}{2}a_y t^2$

Substituting the value of 't' from Step 1, and other known values we get:

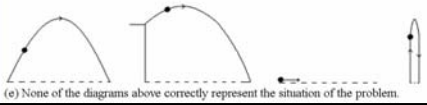
$0 = y_0 + (15.0m/s)(3.46s) + \frac{1}{2}(-9.8m/s^2)(3.46s)^2$

Solving for 'y_0'

$y_0 = 6.80m$

Identify the diagram that correctly represents the situation of the problem.

(a) (b) (c) (d)



(e) None of the diagrams above correctly represent the situation of the problem.

Non-Traditional Problems

Problem Posing

Students given a statement describing a situation, asked to add a question that would turn it into a problem that uses specified principles (equations)

You are given the starting statement of a problem below.

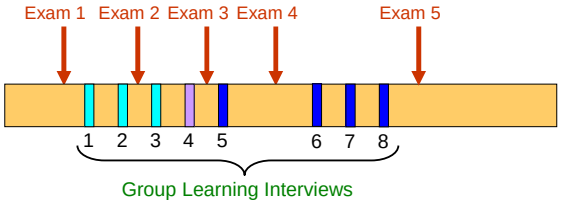
A 500 kg cargo shipment, attached to a parachute, drops vertically out of a helicopter hovering 100 m above a large spring (k = 220,000 N/m). The cargo comes to rest when the spring compression is 0.50 m.

Which question, when added to the statement above, will make a solvable problem that *requires ALL of the following* equations to solve?

$W = Fd$ $W = \Delta KE + \Delta PE$ $PE_{spring} = \frac{1}{2}kx^2$ $PE_{gravity} = mgy$ $KE = \frac{1}{2}mv^2$

(a) What is the speed of the cargo just before striking the spring?
(b) How much time does it takes for the cargo to make contact with the spring?
(c) What is the work done by air resistance acting on the parachute as it drops?
(d) What is the average force of air resistance acting on the parachute as it drops?
(e) None of the above.

Timeline



Group Learning Int. (#1 thru' #3) : Protocol not finalized

Group Learning Int. # 4 : Protocol mostly finalized

Group Learning Int. (#5 thru' #8) : Protocol finalized

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General Information

- Participants
  - All students in 1st semester algebra-based physics (N = 283)
  - Includes students in Group Learning Interviews (N = 9)
- Data Collected
  - Scantron data on all questions in all (five) examinations
  - Includes data on three (extra credit) non-traditional problems at end of each exam

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Exam Performance

- Student performance on average
  - Jeopardy > Text Editing > Problem Posing
    (63% correct) (53% correct) (31% correct)
  - Lower than traditional problems (70% correct)

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Exams : Traditional Problems

Exam #	Group Int. Cohort Mean ± S.E. (N)	Rest of the Class Mean ± S.E. (N)	P value*
1	75.3% ± 6.03%	70.0% ± 1.09%	0.3808
2			0.8559
3			0.4593
4	76.8% ± 4.98% (N = 9)	77.0% ± 0.93% (N = 258)	0.9795
5	79.4% ± 5.99% (N = 7)	77.6% ± 0.99% (N = 258)	0.7655

NO statistically significant difference between cohort and rest of class on traditional exam problems

NONE are ≤ 0.10

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Exams : Text Editing

Exam #	Group Int. Cohort % Correct (N)	Rest of the Class % Correct (N)	P-value*
1	44.5% (N = 9)	35.0% (N = 274)	0.5673
2	77.8%	74.1%	0.8003
3	(N = 9)	(N = 267)	0.7072
4	44.5% (N = 9)	44.6% (N = 258)	0.9339
5	42.9% (N = 7)	47.3% (N = 258)	0.3354

NO statistically significant difference on any exam

NONE are ≤ 0.10

* Logistics test using Binomial model

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Exams : Jeopardy Problems

Exam #	Group Int. Cohort % Correct (N)	Rest of the Class % Correct (N)	P-value*
1	55.6% (N = 9)	52.9% (N = 274)	0.8760
2	[illegible]	[illegible]	0.2348
3	[illegible] (N = 9)	[illegible] (N = 267)	0.8639
4	44.5% (N = 9)	33.7% (N = 258)	0.5127
5	100% (N = 7)	77.9% (N = 258)	0.0635

NO statistically significant difference *except* on Exam 5

Only Exam 5 is ≤ 0.10

* Logistics test using Binomial model

Exams : Problem Posing

Exam #	Group Int. Cohort % Correct (N)	Rest of the Class % Correct (N)	P-value*
1	22.3% [illegible]	34.7% [illegible]	0.4226
2	[illegible]	[illegible]	0.3741
3	[illegible] (N = 9)	[illegible] (N = 267)	0.4117
4	88.9% (N = 9)	36.4% (N = 258)	0.0012
5	57.2% (N = 7)	25.6% (N = 258)	0.0821

NO statistically significant difference *except* on Exams 4 & 5

Only Exams 4 & 5 are ≤ 0.10

* Logistics test using Binomial model

Summary of non-traditional problems assessment

- Student performance on average is lower for non-traditional problem types
- Other observations:
  - Significant difference between cohort and rest of class on Problem Posing & Jeopardy on last 2 exams.
  - It was only on the last 3 exams that the Group Learning Interview protocol was finalized.

Thank You