Students' Performance on Text Editing, Jeopardy and Problem Posing Tasks

Fran Mateycik,[1] N. Sanjay Rebello,[1] and David Jonassen[2]

[1]Kansas State University, [2]University of Missouri - Columbia

1. BACKGROUND

Facilitate the development of Conceptual Schema using Case Reuse.

➢ Conducted semester long treatment in algebra-based physics

➢ Collected Multiple Choice data from five in-class examinations

➢ 3 problems per exam are non-traditional[1,2,3]

2. QUESTIONS

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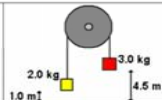- [3]Jeopardy

3. THEORY
Non-traditional tasks

(modified for multiple choice style exams)

[1]**Text Editing:** Students are given a problem statement and asked to find, if any, 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.

[2]**Problem Posing:** Students are given a statement describing a situation, then asked to add a question that would turn it into a problem that uses specified principles or equations.
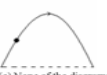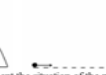
You are given the starting statement of a problem below.

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?

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

(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.

[3]**Physics Jeopardy:** Students are given a fragment of a solution to a problem, then asked to identify a scenario that corresponds to the solution.

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

Step 1: $x = x_0 + v_0 t$ Step 2: $y = y_0 + v_0 t + \frac{1}{2}a_y t^2$

Substituting known values, we get:
$90.0m = 0 + (26.0m/s)t$

Solving for 't':
$t = 3.46s$

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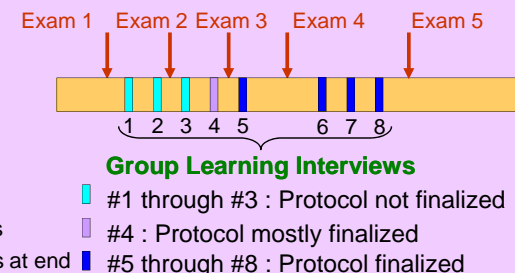(a)   (b)   (c)   (d)

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

REFERENCES

1. R. Low & R. Over, *Australian Journal of Psychology* **42** (1), 63-73 (1990).
2. J. Mestre, *Journal of Applied Developmental Psychology* **23** (1), 9-50 (2002).
3. A. Van Heuvelen & D.P. Maloney, *American Journal of Physics* **67** (3) 252-256 (1999).
4. D.H. Jonassen, *Educational Technology and Research and Development* **48** (4), 63-85 (2000).

4. METHODOLOGY

➢ Participants:
- All students in 1st semester algebra-based physics (N = 283)
- Includes students in Group Learning Interviews (N = 9)

➢ Data Collected:
- Multiple choice data on all questions on all five examinations
- Includes data on three (extra credit) non-traditional problems at end of each exam.

Exam 1   Exam 2   Exam 3   Exam 4   Exam 5

1 2 3 4 5   6 7 8

Group Learning Interviews
- #1 through #3 : Protocol not finalized
- #4 : Protocol mostly finalized
- #5 through #8 : Protocol finalized

5. RESULTS

Average student performance

Jeopardy   >   Text Editing   >   Problem Posing
(63% correct)   (53% correct)   (31% correct)
Lower than traditional problems (70% correct)

Traditional Problems Only

Exam #	Group Int. Cohort Mean ± S.E. (N)	Rest of the Class Mean ± S.E. (N)	P-value*
1	75.3% ± 6.03% (N = 9)	70.0% ± 1.09% (N = 274)	0.3808
2	62.2% ± 6.11% (N = 9)	61.1% ± 1.08% (N = 274)	0.8559
3	69.7% ± 6.22% (N = 9)	65.0% ± 1.14% (N = 267)	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

* ANOVA – Single Factor

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% (N = 9)	74.1% (N = 274)	0.8003
3	55.6% (N = 9)	61.8% (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

* Logistics test using Binomial model

NO statistically significant difference on any exam for Traditional problems OR Text Editing

Problem Posing

Exam #	Group Int. Cohort % Correct (N)	Rest of the Class % Correct (N)	P-value*
1	22.3% (N = 9)	34.7% (N = 274)	0.4226
2	22.3% (N = 9)	36.1% (N = 274)	0.3741
3	11.2% (N = 9)	21.7% (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

Physics Jeopardy

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	100% (N = 9)	92.3% (N = 274)	0.2348
3	55.6% (N = 9)	58.4% (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 Exams 4 & 5

NO statistically significant difference *except* on Exam 5

6. Summary

➢ Student performance on average is lower for non-traditional problem types

➢ There are statistically significant differences on the last two exams:
- Problem Posing (Exams 4 & 5) & Jeopardy (Exam 5)