

## Group Learning Interviews to Facilitate Case-Reuse Strategies in Problem Solving

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## Goal

Facilitate the development of 'conceptual schema' during problem solving using 'case reuse' strategies.

Conceptual schema – a mental map of concepts and their relationships.

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## What is 'Case Reuse'?

Appropriate use of conceptual knowledge learned through a previous case (solved example) to assist in solving an unsolved problem



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## Outline

- I. Treatment
  - I. **Group Learning Interviews**
- II. Assessment
  - I. In-class examinations

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## Treatment Research Questions

- How do students determine whether a given example is useful for solving a different problem?
- How might we refocus student's emphasis on the similarities and differences between problems to include emphasis on deep-structure differences?

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## Previous Research

### Expert vs. Novice

#### Chi (1981)

- Novices focus on surface features of the problem for categorization.
- Experts focus on physics principles applicable to approaching and solving a problem.

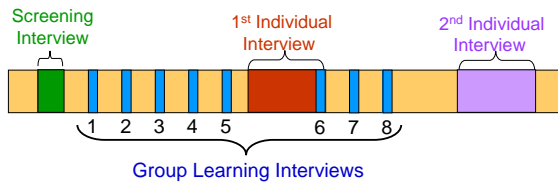
#### Hardiman (1989)

- Surface similarity between problems could interfere with experts' classification of problems.

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## Research Design

### Timeline



- |                      |                               |
|----------------------|-------------------------------|
| 1. 2-D Kinematics    | 5. Rotational Motion          |
| 2. Force             | 6. Pressure in Fluids         |
| 3. Rotational Motion | 7. Simple Harmonic Motion     |
| 4. Work-Energy       | 8. Standing Waves & Resonance |

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## Group Learning Interviews

### General Format

- 10 students from algebra-based physics
  - 7 women, 3 men
  - 2 Hispanic, 8 Caucasian
- 8 weekly focus group meetings
  - 75 minutes each
- Students work in pairs
- Activities modified during initial 4 weeks

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## Group Learning Interview #1

### Method

For each problem, students were individually asked to:

1. Identify and interpret the principles involved in problem.
2. Represent problem using a picture (e.g. Free body diagram)
3. Specify if problem has sufficient, missing, irrelevant info.
4. Use principles and equations to solve problem.

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## Group Learning Interview #1

### Method

As a pair, students were asked to:

1. Explain your solution to your partner.
2. Discuss similarities and differences with partner's problem.

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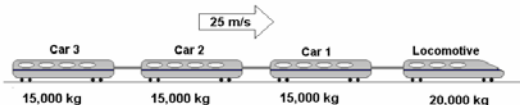
## Group Learning Interview #1

**Problem A**  
A 20.0 kg box rests on a 70.0 kg table. A 10.0 kg box is placed on top of the 20.0 kg box as shown in the figure below.

(a) What is the force that the 10.0 kg box applies on the 20.0 kg box?  
(b) What is the force that the 20.0 kg box applies on the 70.0 kg table?

**Problem B**  
A train locomotive, mass 20,000 kg moving at a constant speed of 25 m/s is pulling three cars each of mass 15,000 kg behind it. The tension in the coupling connecting the locomotive to Car 1 is 300,000 N.

(a) What is the tension in the coupling connecting Car 1 to Car 2?  
(b) What is the tension in the coupling connecting Car 2 to Car 3?



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## Group Learning Interview #2

### Method

Similar to Int. # 1, but introduced 'stopping points'.

5. Explain your solution to your partner.
  - STOP** Signal to Sanjay or Fran that you have completed tasks 1-5
6. Discuss any similarities and differences that your problem has with your partner's problem.
  - STOP** Signal to Sanjay or Fran that you have completed task 6
7. Work together with your partner to create a new problem which incorporates elements of both problems previously discussed.

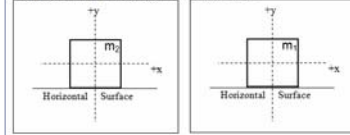
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## Group Learning Interview #3

### Method

More **procedural scaffolding** provided to shift focus from procedure to concepts.

Step 2: Draw the Free-Body Diagrams for block 1 and 2



Step 3: Write expressions for Newton's Second Law for the forces in the x and y direction for each block. Note: Both blocks are in line and both have the same frequency, so they will stay in line with each other as they rotate around the table.

Block  $m_1$ : x direction

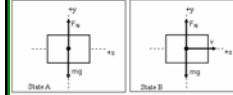
Block  $m_1$ : y direction

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## Group Learning Interview #4

**Prob. C was solved for the students by moderator before they were given either Prob. A or Prob. B**

**Problem C**  
A 10 kg bow is fired along a horizontal table applying an average force of 200 N. The bow starts at rest and reaches a velocity of 12.0 m/s. Neglect friction, how far did the bow travel the bow?



**SOLUTION**

We may express the work done by Justice on the bow in terms of the force applied and the distance covered which Justice applied the force.  
We know that since the bow will be moving in the same direction as the force applied, the angle between the direction of force and direction of

$$W = Fd \cos(\theta) = Fd$$

$$\Rightarrow W = Fd = (200 \text{ N})d$$

We also know that the work done on the bow must be equal to the change in kinetic energy. Since the bow was at rest initially our initial kinetic energy will be zero.

$$W = KE_f - KE_i = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$$

$$\Rightarrow W = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$$

$$\Rightarrow W = \frac{1}{2}mv_f^2$$

$$\Rightarrow W = \frac{1}{2}(10 \text{ kg})(12.0 \text{ m/s})^2 = 720 \text{ J}$$

Finally, we have expressed the work done on the bow using two different equations above. We may set both expressions for Work equal to one another.

$$W = (200 \text{ N})d = 720 \text{ J}$$

$$\Rightarrow d = \frac{720 \text{ J}}{200 \text{ N}} = 3.6 \text{ m}$$

**Problem A**

A 0.10 kg arrow is fired from a bow. The bow is pulled back a distance of 0.8 m so that the arrow is released with a speed of 50 m/s as it leaves the bow. The arrow travels 25.0 m before hitting its target. What is the average force exerted on the arrow by the bowstring?

**Problem B**

A Yankees batter hits a 0.14 kg baseball sending it off into left field, 40 m away from the batter's box. The baseball lands in a Royals fielder's glove, exerting an average force of 300 N, moving the glove backward 0.25 m before coming to rest. What is the speed of the ball just before it is caught?

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## Group Learning Interview #4

### Method

Step 10: Individually, Rate the similarity between Problem A and Problem B on the scale below.



Step 11: Individually, rank the Similarities and Differences based upon how important these are during problem solving (Rank 1 = most important). If two Similarities or Differences are equally important, you may give them the same rank.

SIMILARITIES		DIFFERENCES	
Rank	Description	Rank	Description

Step 12: Discuss the Similarities and Differences between Problem A and Problem B with your team mate(s).

**STOP** Signal to Teacher or Prox that you have completed step 12

Step 13: Work together with your team to create a new problem which incorporates elements of all problem A, B and C discussed today. Word this problem carefully so that it can be solved by someone else.

**STOP** Signal to Teacher or Prox that you have completed step 13

Changes:

- Moderators go over Problem C solution.
- Students Individually rate & rank:
  - similarities between A, B & C
  - usefulness of C in solving A or B.

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## Group Learning Interview # 5 through #8

Same protocol as Group Learning Interview # 4

Except  
Students are asked to read through the solution to Problem C and moderators addressed questions that students asked

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## Summary of Group Learning Interviews

### General Observations

- Similarities
  - Focus on deep structure
  - Surface features rank lower than deep structure
- Differences
  - Focus on surface features
- Usefulness
  - 'Mathematical trickery' lessens usefulness ratings every time

**Still focus on procedure more than concepts**

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## Summary of Group Learning Interviews

### What we Learned

- Difficulty level of problems must be carefully adjusted
  - Too difficult: focus on solving problem, not on reflection
- We need to provide scaffolding in the form of:
  - solved example before unsolved problems
  - questions asking them to enunciate principles
  - structure for reflecting on similarities/differences

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