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.

What is 'Case Reuse'?

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

Outline

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

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?

Previous Research

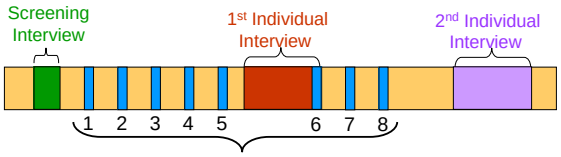
Expert vs. Novice

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.

Research Design

Timeline



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

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

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.

Group Learning Interview #1

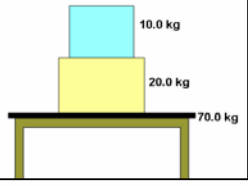
Method

As a pair, students were asked to:

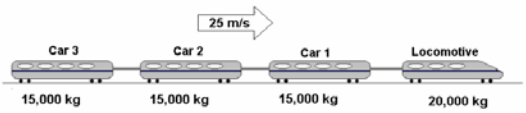
1. Explain your solution to your partner.
2. Discuss similarities and differences with partner's problem.

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?



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.

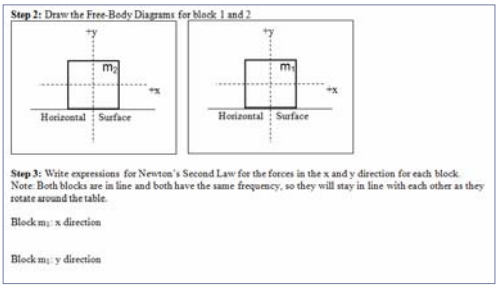
STOP **Signal to Sanjay or Fran that you have completed task 6**

7. Work together with your partner to create a new problem which incorporates elements of both problems previously discussed.

Group Learning Interview #3

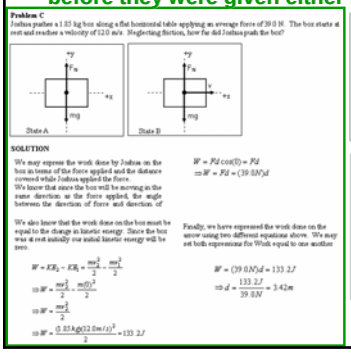
Method

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



Group Learning Interview #4

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



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?

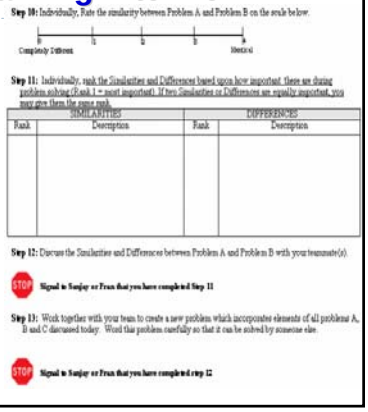
Problem B
A Yankees batter hits a 0.14 kg baseball sending it off into left field, 40 m away from the batter's box. The baseball lands in a Royals fielder's glove, exerting an average force of 300 N, moving the glove backward 0.25 m before coming to rest. What is the speed of the ball just before it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

Group Learning Interview #4

Method

Changes:

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



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

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

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