

Students' Understanding of Inclined Planes Using the CoMPASS Curriculum



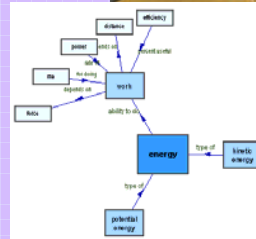
Jacquelyn J. Haynicz & N. Sanjay Rebello, Kansas State Univ.; Sadhana Puntambekar, Univ. of Wisconsin – Madison



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1. Introduction

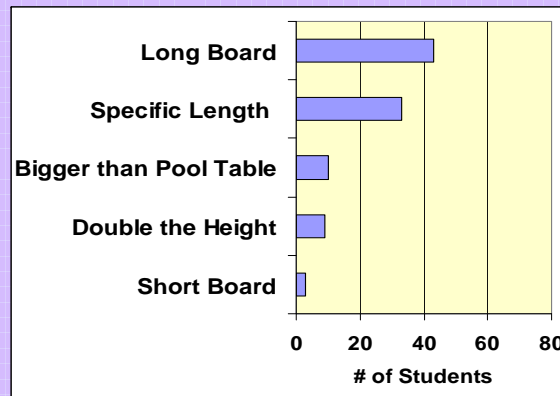
- CoMPASS¹ (Concept Map Project-based Activity Scaffolding System) integrates hypertext exploration with hands-on experimentation in a design-based pedagogy.
- Context of Study: Inclined Planes
- Research Questions:
 1. Before instruction, how did students predict the
 - a) length of ramp to complete their design challenge?
 - b) surface of a ramp to complete their design challenge?
 2. After instruction, to what extent did students understand the
 - a) relationship between effort force and distance?
 - b) relationship between effort force and steepness?
 - c) usefulness of an inclined plane?



2. Methodology

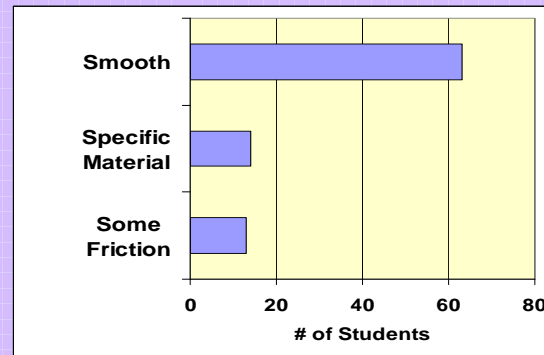
- Participants: N=85, conceptual physics, future elementary teachers; 93% female, 92% 18-22 years old.
- CoMPASS challenge: Design the best ramp to load a pool table into a van.
 - Complete a pre-test and anticipation guide
 - Predict the length and surface of ramp to best complete the challenge
 - Pose questions that they should learn about to complete their challenge
 - Use CoMPASS hypertext system to answer the questions posed
 - Experimentally explore relationship between length or surface and effort force
 - Complete open-ended summary questions and a post-test
- Analysis:
 - Qualitative: Phenomenographic² analysis of written responses.
 - Quantitative: Performance on the multiple choice test.

3. Length Predictions



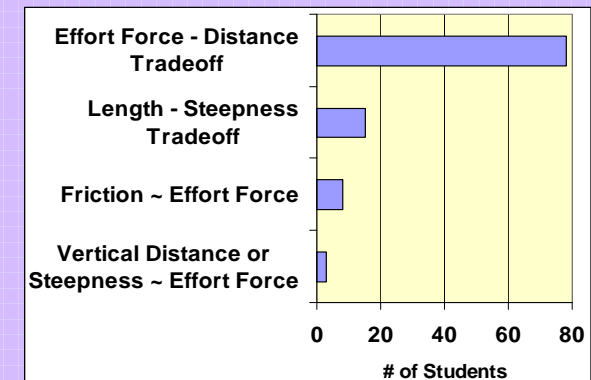
- Long board (43/85). "... it will make the effort small."
 - Most popular reason (24/43) : "small incline".
 - Other reasons : Less effort (6/43), Less force (5/43)
 - Everyday reasoning: e.g. "table is heavy & wide".

4. Surface Predictions



- Smooth surface (63/85). "... nothing interfering with it."
 - Most popular reason (32/63) : Less friction.
 - Other reasons (9/63) : "minimize energy".
- Other predictions (13/85): some friction to keep the person or pool table from slipping or sliding back
 - "...so you won't slide on the smooth surface."

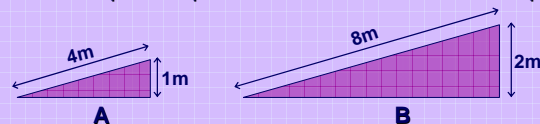
5. Effort Force vs. Distance



- After instruction, most (78/85) students showed evidence of understanding the concept of Force-Distance tradeoff.
 - "The longer the distance of an inclined plane, the less effort force is needed to push an object up the inclined plane."

6. Effort Force vs. Steepness

Which ramp will require the least effort force to slide up?

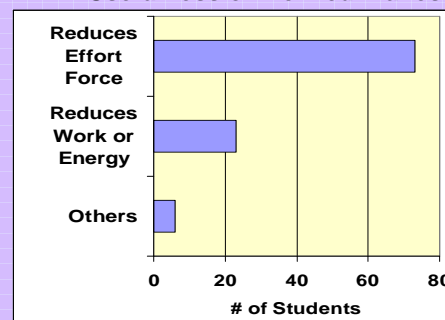


C: Both the same

D: Not enough information

- Correct Answer: C (28% on Pre-test, 45% on Post-test)
 - Appear to understand Effort Force vs. Steepness.
- Most common Incorrect Answer: A (69% on Pre-test, 40% on Post-test)
 - Difficulty relating effort force to the incline's steepness.
 - Focus on height or length alone, not combination.

7. Usefulness of Inclined Planes



- Most (75/85) referred to reduced effort force
- Some (23/85) referred to reduced work or energy
 - Appear to conflate concepts of force and work/energy.

8. Conclusions

- Most students' correctly predict that longer (43/85) and smoother (63/85) boards will better complete their challenge.
 - Students' responses show evidence of everyday reasoning, not necessarily physical principles alone.
- Students' responses to worksheet and pre/post-test questions show evidence that they
 - mostly (78/85) understand the of the relationship between effort force and distance, but.
 - many (34/85) do not understand the relationship between effort force and steepness after completing the unit.
- Students' mostly (75/85) appear to understand that the incline plane is useful in reducing effort force. However, some (23/85) also state that it reduces work or energy.
 - Some responses indicate that students' tend to conflate force with work/energy.