



School of Physics and Astronomy, University of
Edinburgh

Towards a Conceptual Inventory in Quantum Mechanics

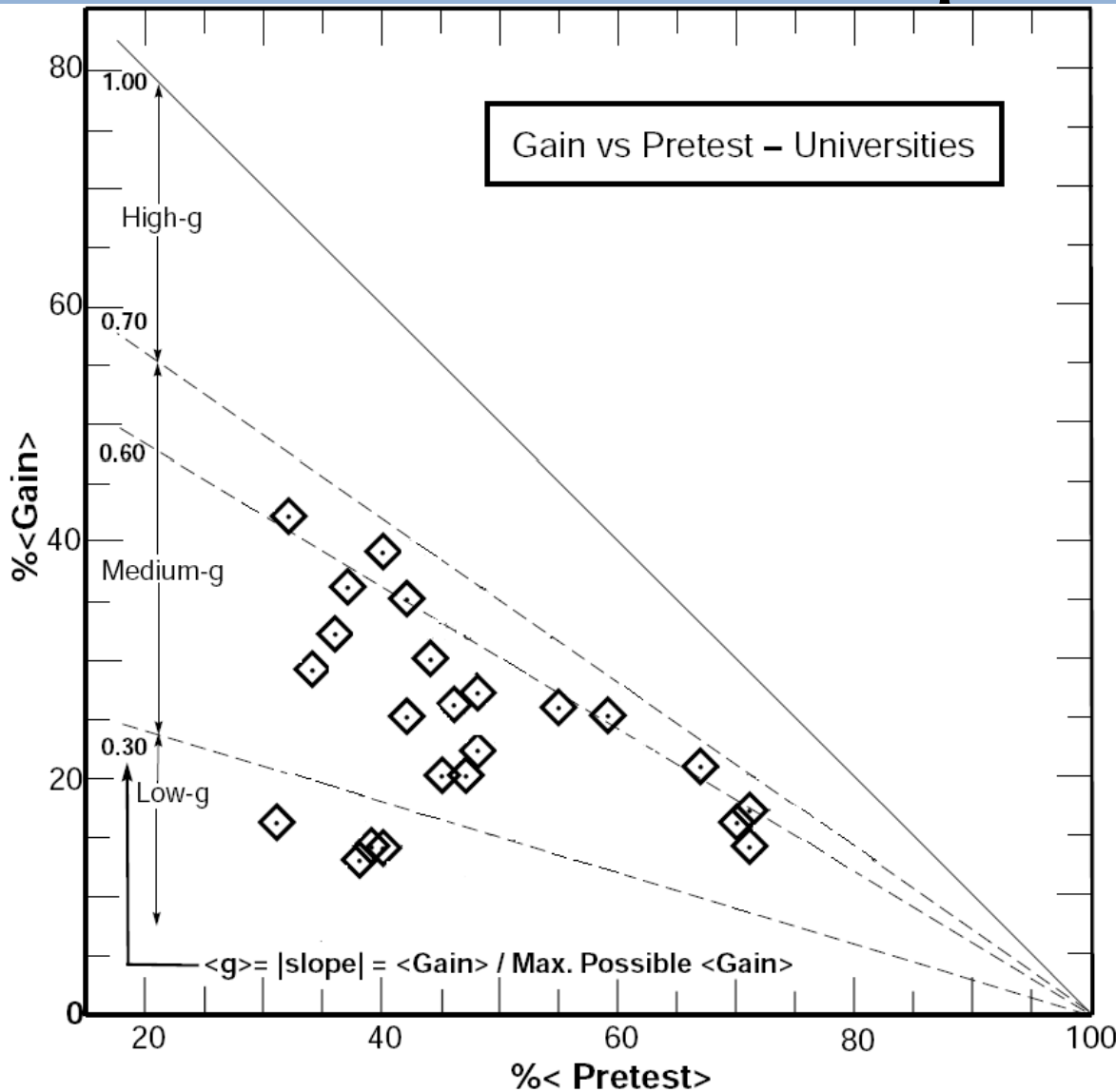
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Diagnostic Test



- Test student conceptions
 - Common misconceptions
- Delivered before and after course
 - Effectiveness of instruction
- 1st year ‘Classical Mechanics’ course
 - ‘Force Concept Inventory’

Force Concept Inventory



Ref: Richard R. Hake. “Interactive-engagement vs traditional methods: A six-thousand survey of mechanics test data for introductory physics courses.”



‘Classical Mechanics’ Question

Four forces, F_1 , F_2 , F_3 and F_4 are exerted together on a hockey puck. The puck moves at a constant speed along a straight line in the direction of F_4 . The arrows in the figure represent the directions of the four forces but not their magnitudes. Which of the following relationships represents best how the magnitudes of the four forces are related?



- a. $F_4 = F_2$ and $F_3 = F_1$
- b. $F_4 = F_2$ and $F_3 > F_1$
- c. $F_4 > F_2$ and $F_3 > F_1$
- d. $F_4 > F_2$ and $F_3 = F_1$
- e. $F_4 > F_2$ and $F_3 < F_1$



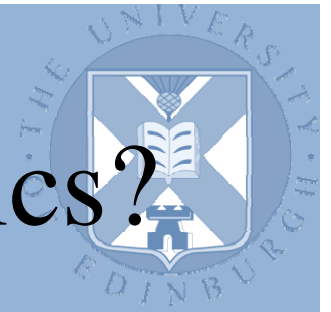
Results



- a. $F4 = F2$ and $F3 = F1$
- b. $F4 = F2$ and $F3 > F1$
- c. $F4 > F2$ and $F3 > F1$
- d. $F4 > F2$ and $F3 = F1$
- e. $F4 > F2$ and $F3 < F1$

- Answer A is correct
 - All incorrect responses choose the same wrong answer d
- This result has persisted throughout the years

What about Quantum Mechanics?



- Conceptually challenging topic
- No everyday experience
 - Free from misconceptions that classical mechanics has
- Counter-intuitive
- Cornerstone of modern physics

Preliminary Investigation



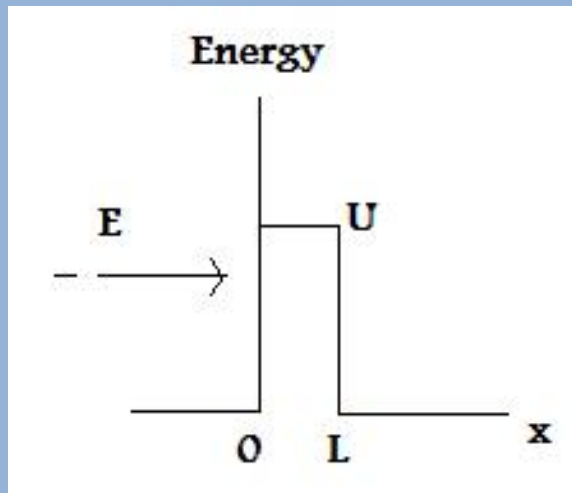
- Project undertaken as part of senior honours BSc in Physics
 - One semester long
- Aim was to devise and administer an introductory diagnostic test
 - Delivered pre and post an introductory level Quantum Mechanics course
- Seeking common misconceptions from analysis of test results
- Quantising improvement with instruction

Common Misconception

Question in the Diagnostics Tests

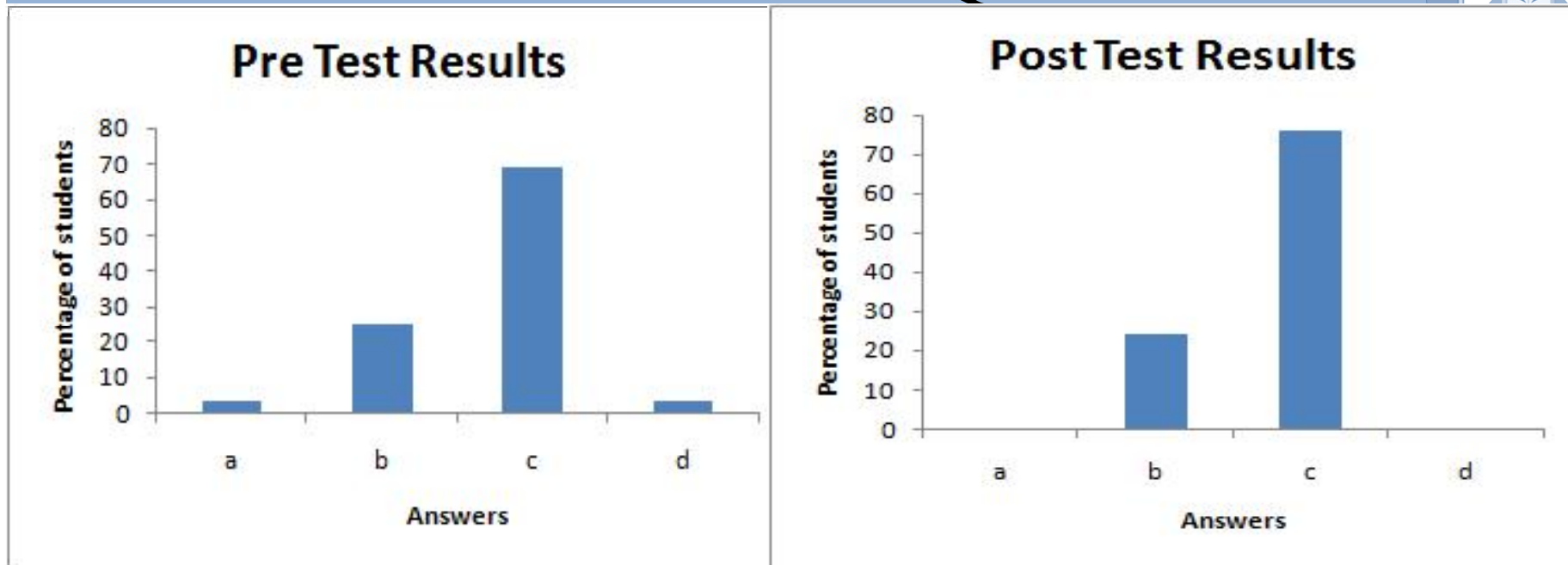


The total energy of an electron after it tunnels through a potential energy barrier is. . .



- a. . greater than its energy before tunnelling
- b. . equal to its energy before tunnelling
- c. . less than its energy before tunnelling
- d. Do not know

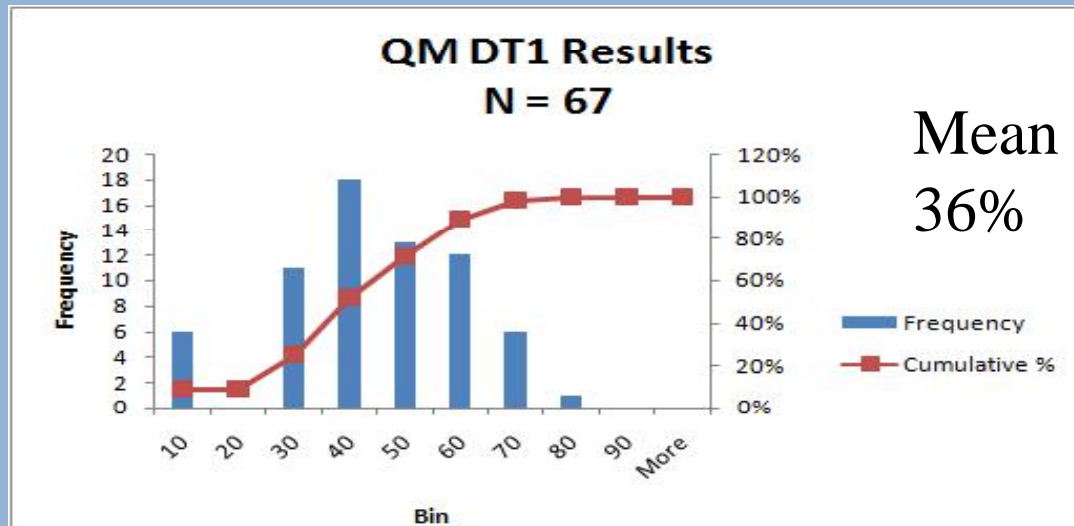
Results from Question



- Marginal change before and after course
- Similar result to the 'Classical Mechanics' question
- Misconception persists post instruction

Common Misconception: Energy is lost after tunnelling through a barrier

Overall Improvement During the Course



- Significant improvement after instruction

Mean:
55%

Work in Progress



- One year research MSc
 - Funded by the Physical Sciences Centre and UoE
- Further exploration of student conceptions in Quantum Mechanics
 - In both Physics and Chemistry
- Construct Questions
- Deploy test and validate



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