Renovating laboratory teaching:
introducing Experimental Tutorials

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Science Learning & Teaching Conference

Keele University

19th June 2007

UNIVERSITY of GLASGOW

Introduction

- Recent years had seen a growing dissatisfaction with the practical level 1 physics course.
  - Students found it dull and a chore.
- It was decided that a major renovation was needed to remedy this situation.

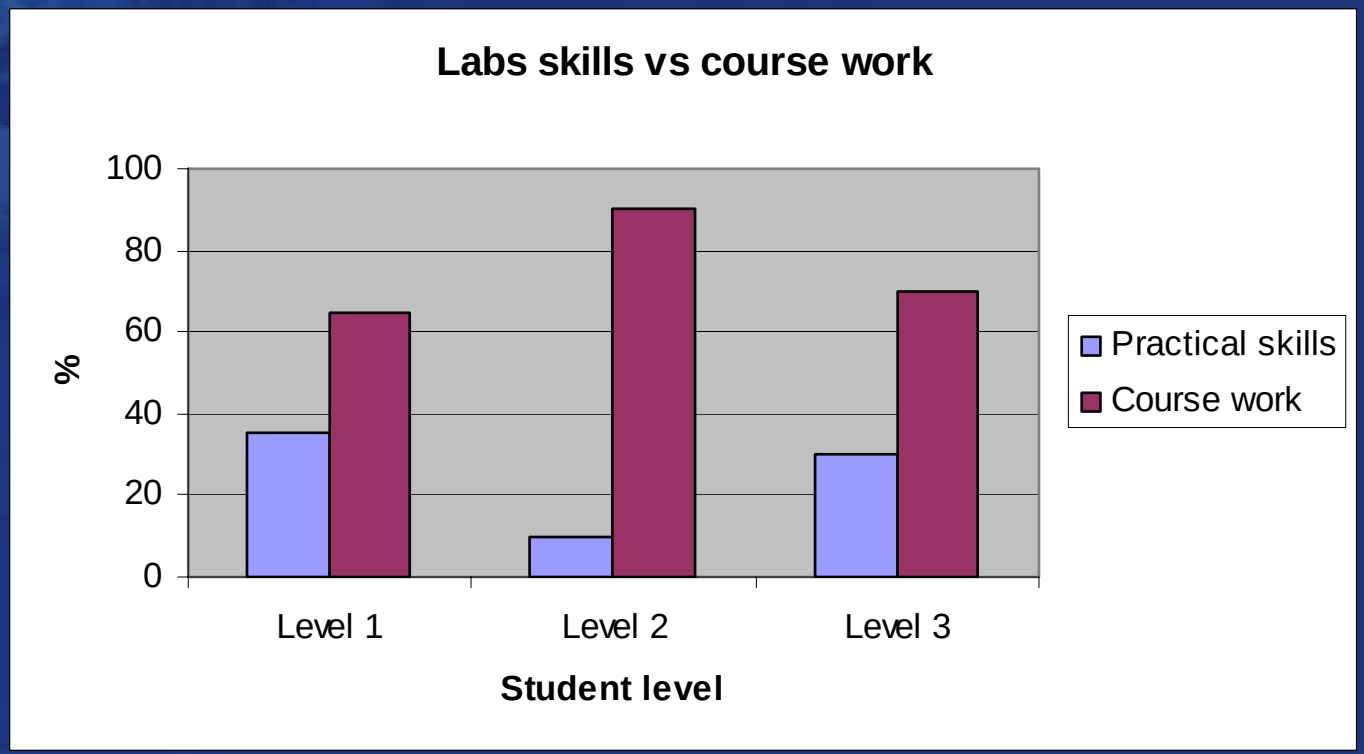
Student preferences

- Before the renovation, level 1 (and ex-level 1) students were asked what they were looking for from the lab class.

- *Note – the levels mentioned here refer to the Scottish university levels. i.e. level 1&2 are "pre-Honours", level 3/4/5 are "Honours".*

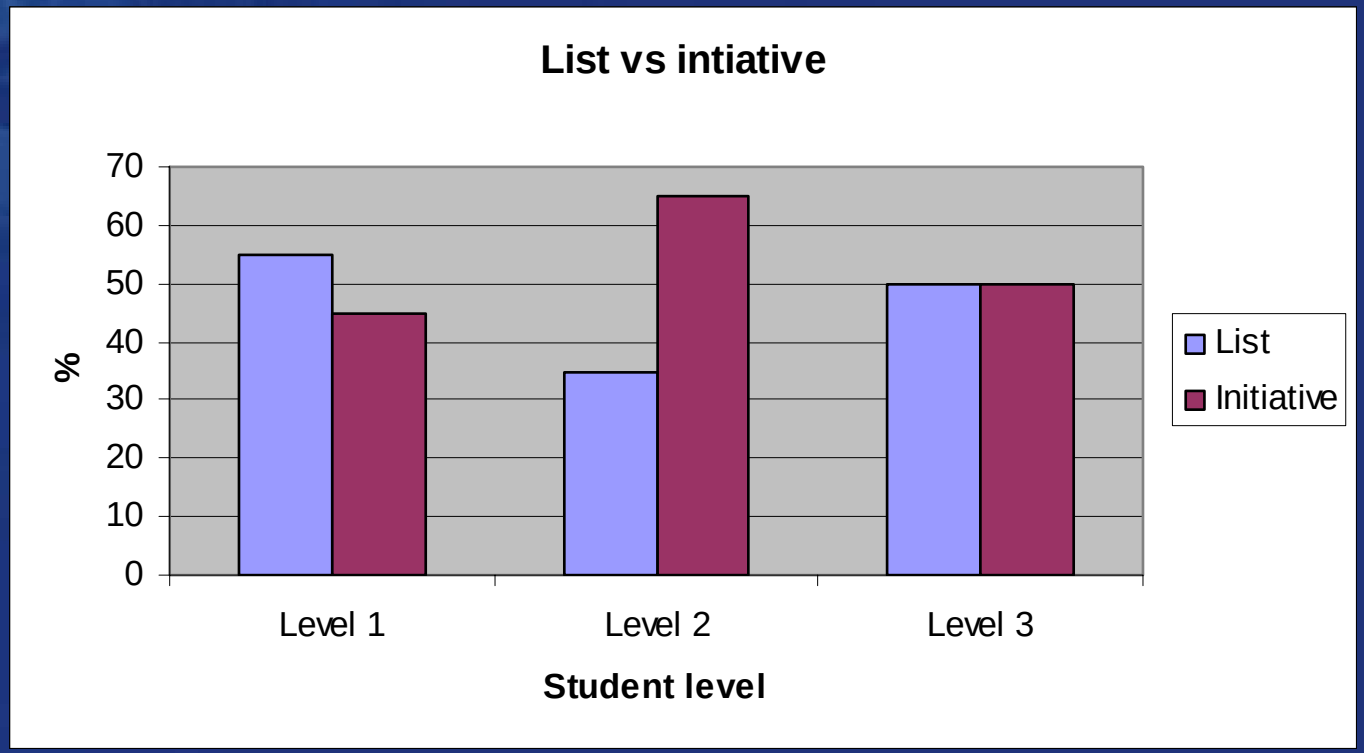
Student preferences

- A place to learn new, practical skills or to illustrate course work?



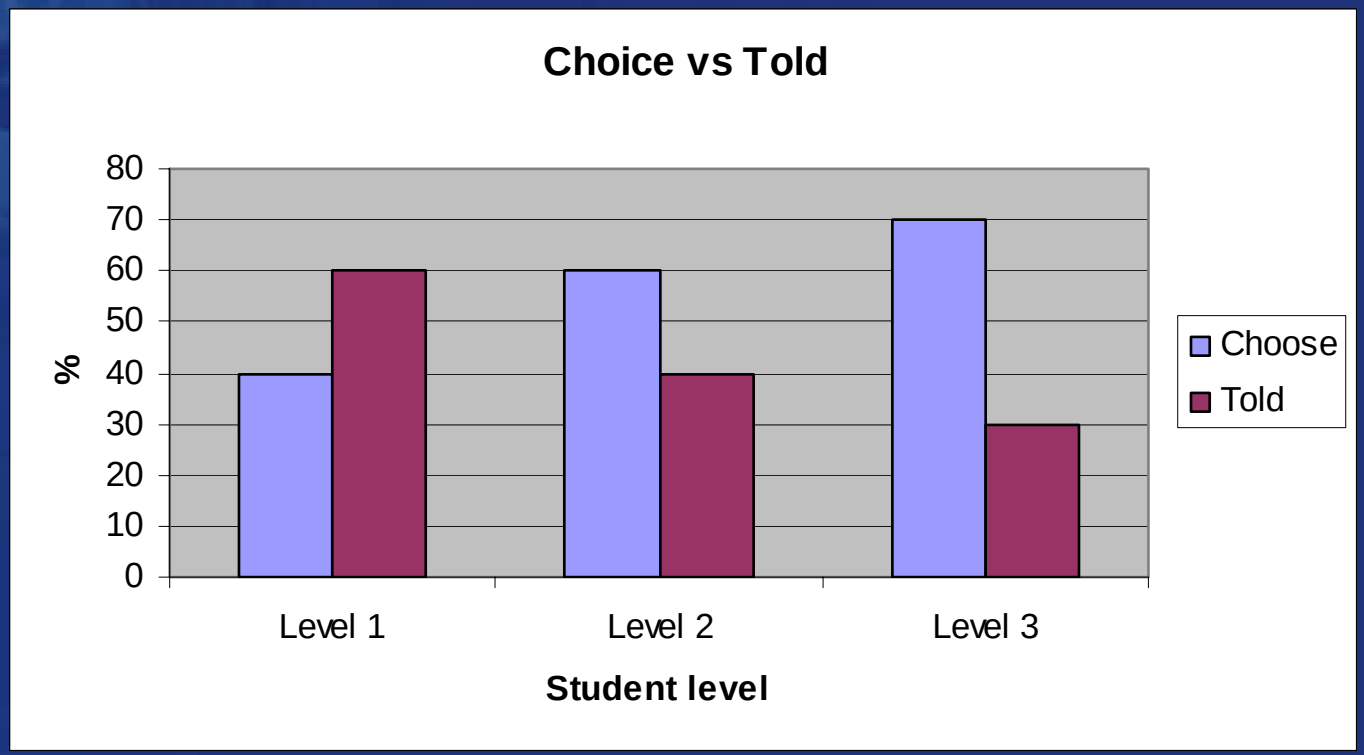
Student preferences

- Work through a list of instructions or use own initiative?



Student preferences

- Choose experiments from a list or told which to do?



Student preferences

- Work alone or in pairs/groups?
  - Level 1 students: >90 % pairs/groups
  - Level 2 students: >90 % pairs/groups
  - Level 3 students: >90 % pairs/groups
- Greater use of computer simulations or tutorials?
  - Level 1 students: >90 % tutorials
  - Level 2 students: >90 % tutorials
  - Level 3 students: >90 % tutorials

Aims of renovations

- Create direct illustrations of lecture material.
- Encourage more free-thinking on the part of the students.
- Bring in more research-style methodology.
- Create a faster paced working environment.
- Replace outmoded equipment.

Experimental tutorials (ETs)

- A new structure of lab exercise.
  - A theoretical tutorial exercise *and*
  - an experiment directly linked to that exercise.
- Designed to address students' desire to see the lab illustrate lecture material.
- E.g. …

Hooke's Law and SHM

- Tutorial question

Motion of this mass is described by

$$x = A\sin\left(\frac{2\pi}{T}t\right)$$

– *Sketch this motion.*

The extension force is given by

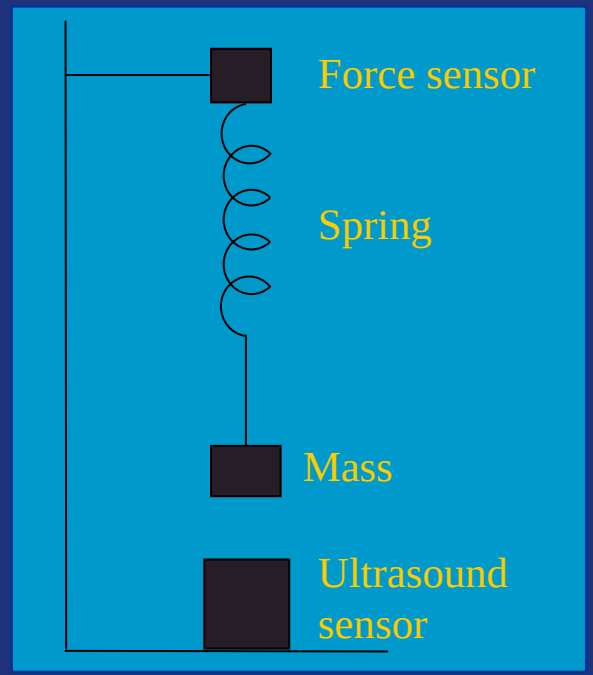
$$F = -kx$$

– *Add a graph of force to your sketch.*

The period of the oscillations is given by

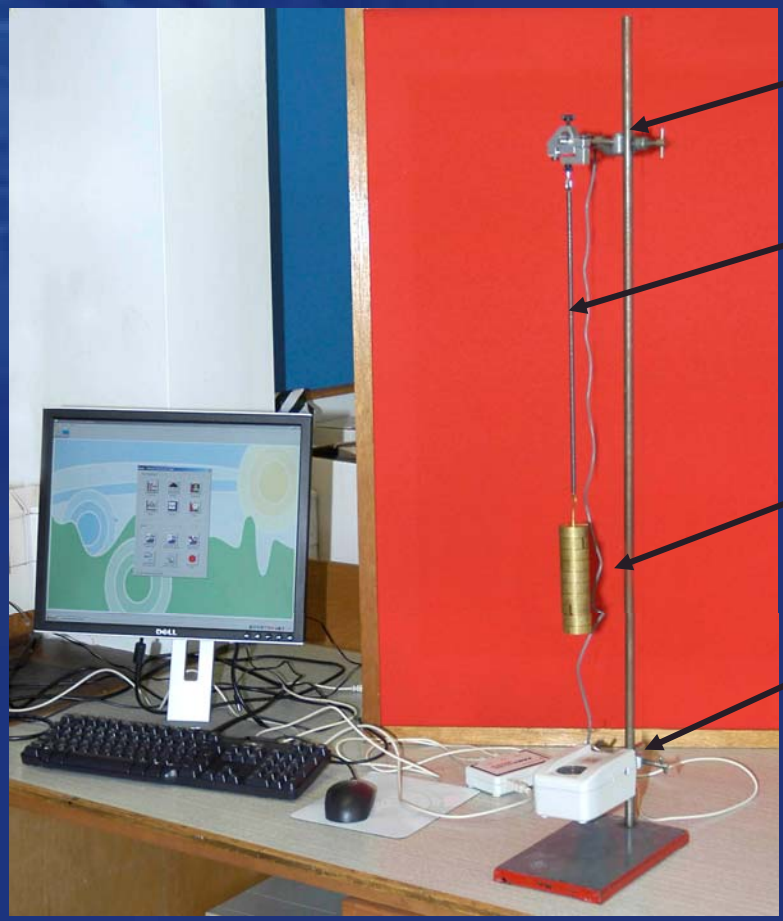
$$T = 2\pi\sqrt{\frac{m}{k}}$$

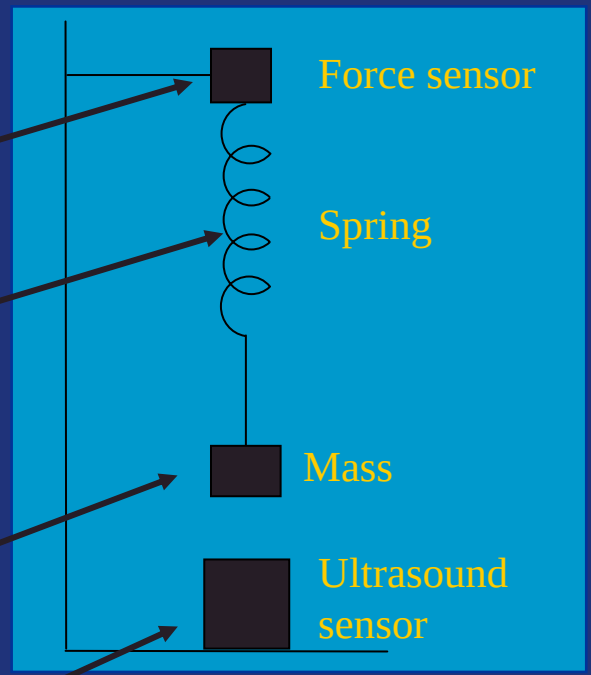
– *If T = 0.5 s and m = 2 kg, calculate the spring constant, k.*



Hooke's Law and SHM

- Experiment





Additional tasks

- Opening session focussed on I. T. skills.
- Final session of the term focussed on teamwork skills.
  - Problems tackled in groups of four.
  - Assessment by means of presentation made after ~ 75 minutes.

Results – staff p. o. v.

- Students carried out 2 ETs per week, allowing a large proportion of the coursework to be covered.
  - 90 mins per ET.
- Activity in the lab greatly improved
  - the periods of clear boredom from the old system were gone.

Results – student p. o. v.

- Students were asked to rank the lab class
  - 60 % Excellent/Good
  - 37 % Fair
- Students were asked to rank demonstrators
  - 77 % Excellent/Good
  - 17 % Fair

Results – student p. o. v.

- Compared with Astronomy level 1 labs, Physics was viewed as comparable.
  - An improvement!
- Compared with Chemistry level 1 labs, unfortunately, Physics was still the poor relation.
  - No change there.

Why was Chemistry better?

- Students were asked to comment on their comparison with Chemistry.

- Responses fell into two categories:
  - Chemistry labs were less rushed and better organised.
  - Chemistry labs were “easier”.

Conclusions

- Create direct illustrations of lecture material.
  - Each ET specifically tied into aspects of preceding lectures.
- Encourage more free-thinking on the part of the students.
  - Students had to work out what to do with data, which equations to use and so on.

Conclusions

- Bring in more research-style methodology.
  - Many experiments used PC packages to get data and analyse results.
- Create a faster paced working environment.
  - Experiments became shorter and students attempted more of them.
- Replace outmoded equipment.
  - A great deal was bought.

Conclusions

- Overall, these renovations were a great (though not flawless) success.
- Just the first step in an on-going process to get, and then retain, the students' interest in the practical side of Physics.