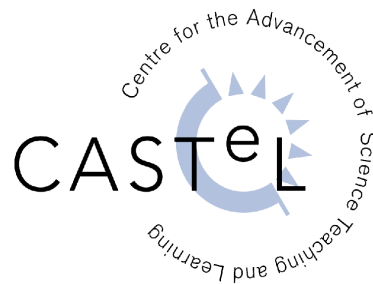


Improving the graphing literacy of undergraduate science students

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In summer 2006 we were asked by faculty to change the physics labs for general science students

Who are the students?

- 200 non-physics science students at first year university level
- 75% had done a limited amount of physics up to the age of 15



WHAT WERE THE GOALS

- Enjoyable

Last time many will experience formal physics education

- Skills

Allow students to develop transferable skills.

Make the labs relevant for non-physics students

- Basic physics

Introduce students to fundamental physics ideas and models, challenge students' preconceptions.



What did we change?

- A Guided Inquiry approach was taken
- The experiments were changed to be at a level that was appropriate to the students attending
- Simple materials were used
- The labs were made non rotational





Characterising the labs.

Reasoning	Inductive
Equipment	Simple (no black box)
Material	A structure, guides students' reasoning
Tutors' role	Scaffolds students' reasoning. Socratic questioning.



INQUIRY VS TRADITIONAL LABS

Inquiry labs have a strong focus on Inductive Reasoning

Guided Inquiry	Traditional Labs
<p data-bbox="582 686 963 742">Scientific Model</p>  <p data-bbox="638 1149 929 1204">Observation</p>	<p data-bbox="1108 670 1489 790">Lab experience & Verification</p>  <p data-bbox="1086 1157 1467 1212">Scientific Model</p>



FOCUS ON SKILLS

Skill	Breakdown
Graphing skills	<ul style="list-style-type: none">• Intercept• Intrapolation,extrapolation• Slope + physical meaning• Shape of graph and physical meaning• Measuring tangents of slopes
Measurements	<ul style="list-style-type: none">• Use Vernier Callipers
Hypothesis testing	
Control of variables	<ul style="list-style-type: none">• Identifying independent and dependent variables. Setting up an experiment.
Drawing Tables	<ul style="list-style-type: none">• Labeling
Simple mathematical representations	



WHAT LABS DID WE END UP WITH

	Labs
1	Hooke's law
2	Balancing Blocks
3	Pendulum
4	Uniform motion
5	Non-Uniform motion
6	Forces
7	Buoyant Force
8	Magnetic forces
9	Investigation 1
10	Investigation 2



Autonomy

In short we were able to develop a relatively cheap and effective set of guided inquiry labs.



From a students perspective

Before entering the labs:

- Pre-test online
- Online survey on previous lab
- Complete a pre-lab

During the labs:

- Given the equipment, students work through a set of worksheets during regular labs
- They must design and carry out investigations during weeks 9 and 10

After the labs:

- Students sit a midterm test and a final exam:
- Part of the final exam involves students carrying out an investigation
- There is also a final survey that students take online:



WHAT DID THE STUDENTS THINK

○ Enjoyment

60% agreed or strongly agreed that they enjoyed most of the labs
20% neutral and 20% disagreed or strongly disagreed

○ Skills

75% of students agreed or strongly agreed that they acquired skills that could be useful to their future study

○ Atmosphere

85% of students agreed or strongly agreed that the atmosphere was positive in the labs.

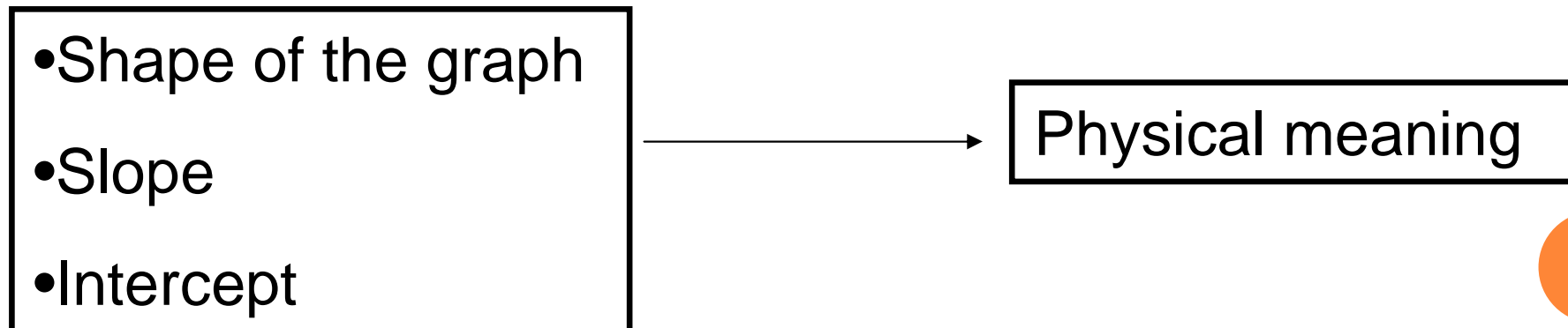


Part 2: Graphing as a transferable skill

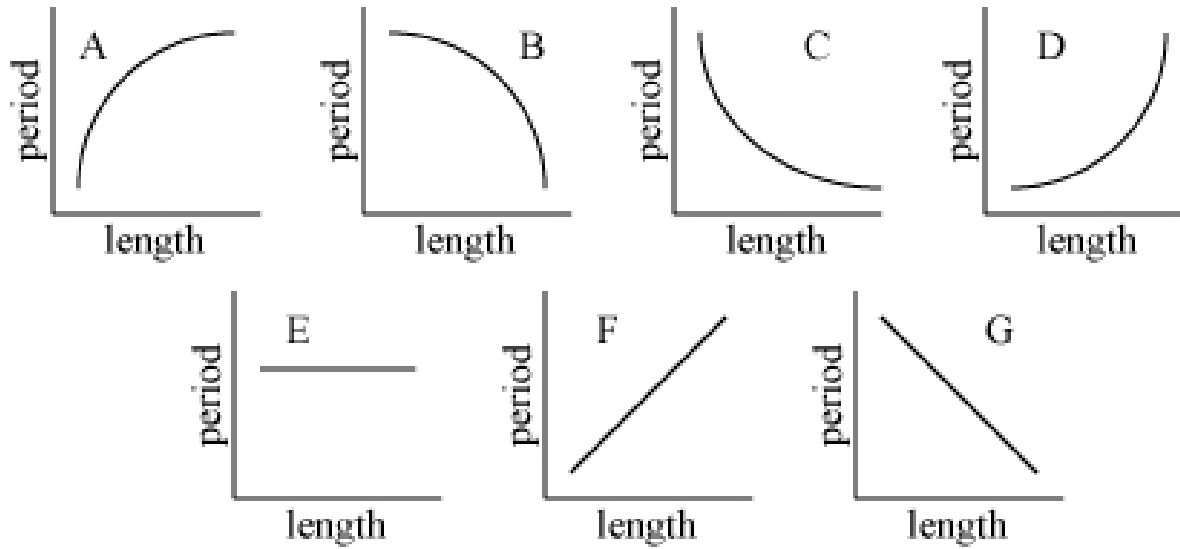


Testing how well it works

- We wanted students to develop a transferability of graphing skills
- During the labs we worked on different aspects of graphing. Slopes, intercepts, Tangents, extrapolation, intrapolation



Pendulum lab



- During the pendulum lab students must choose the correct shaped graph to draw
- Students during the course of the labs qualitatively link the shapes of graphs with their physical meaning



Testing transferability of graphing

- Reduce the difficulty concept as much as possible

Concept
understanding

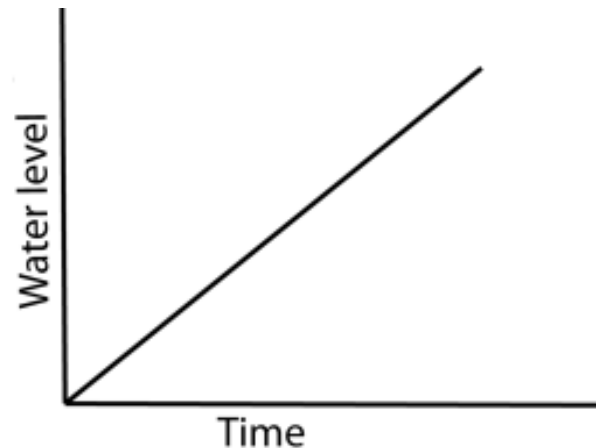
Graphing Literacy

- We wanted to see if students could represent real physical situations in qualitative graphs
- We wanted to ask students questions on graphs they were unlikely to have seen before.



Post-Test (Graphing Literacy)

- Students were asked to draw a qualitatively correct graph of water level versus time for a constant flow of water into a water beaker.

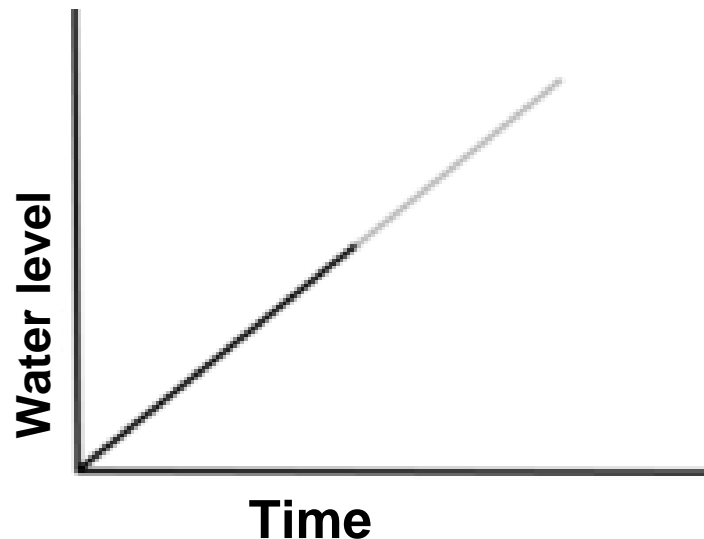
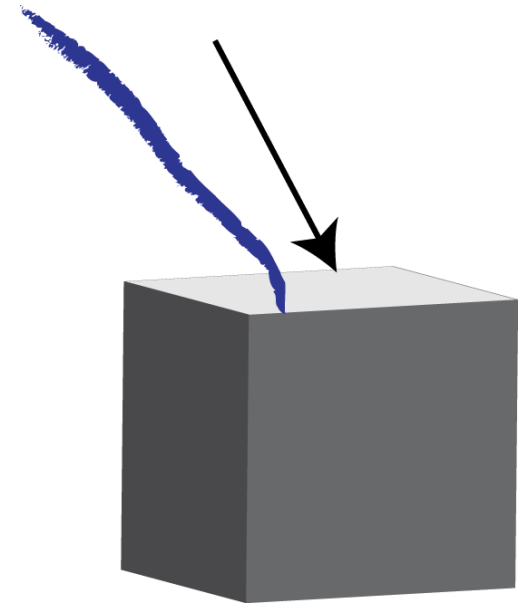


- 68 out of 69 students gave the correct answer above.



Post-Test (Graphing Literacy)

- *Asked the same question again but the beaker is only half the original height. Students sketch the original graph again and the new graph.*



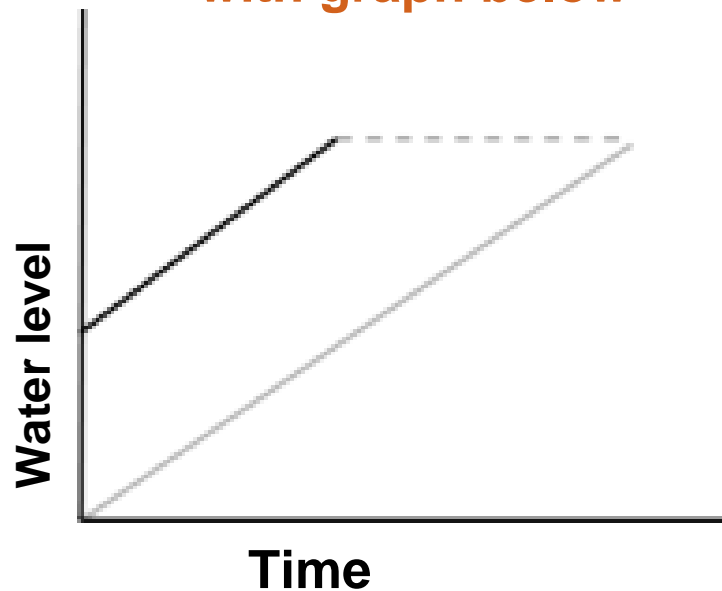
60% answered correctly



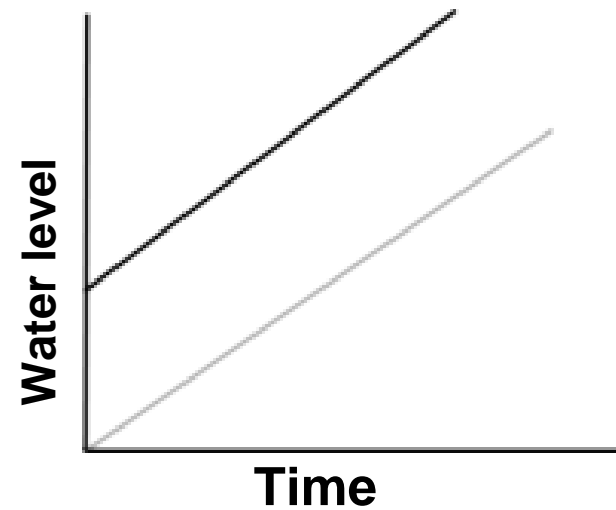
Post-Test (Graphing Literacy)

- *Asked the same question again but this time there is water already in the beaker. Students sketch the original graph again and the new graph.*

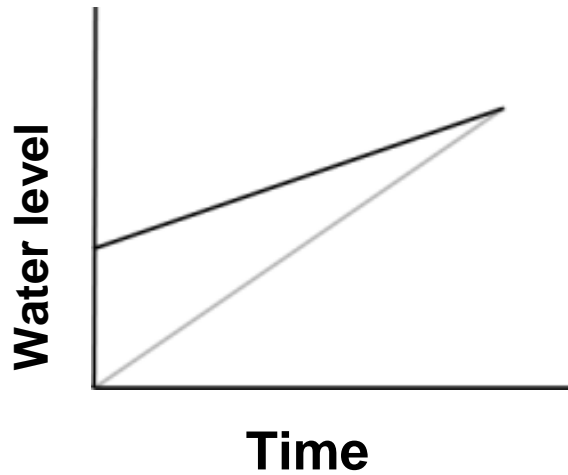
10% answered
with graph below



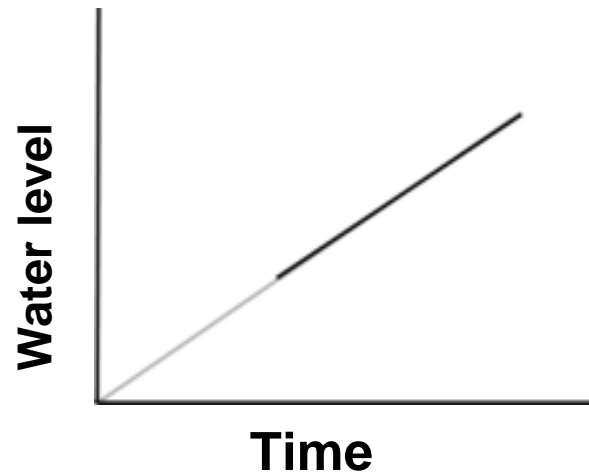
40% answered with
graph below



Some of the wrong answers



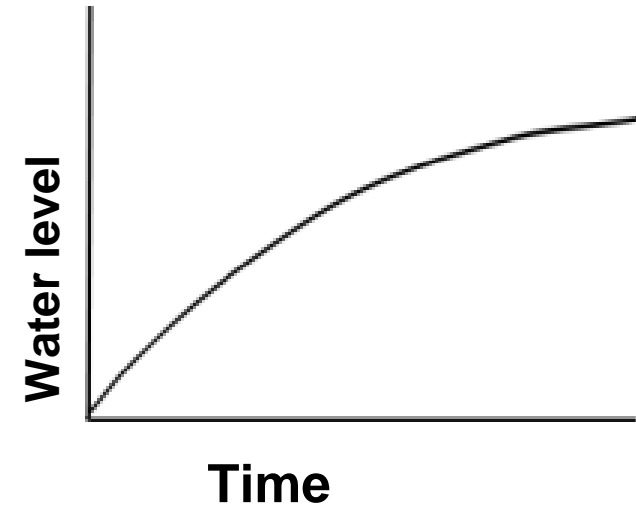
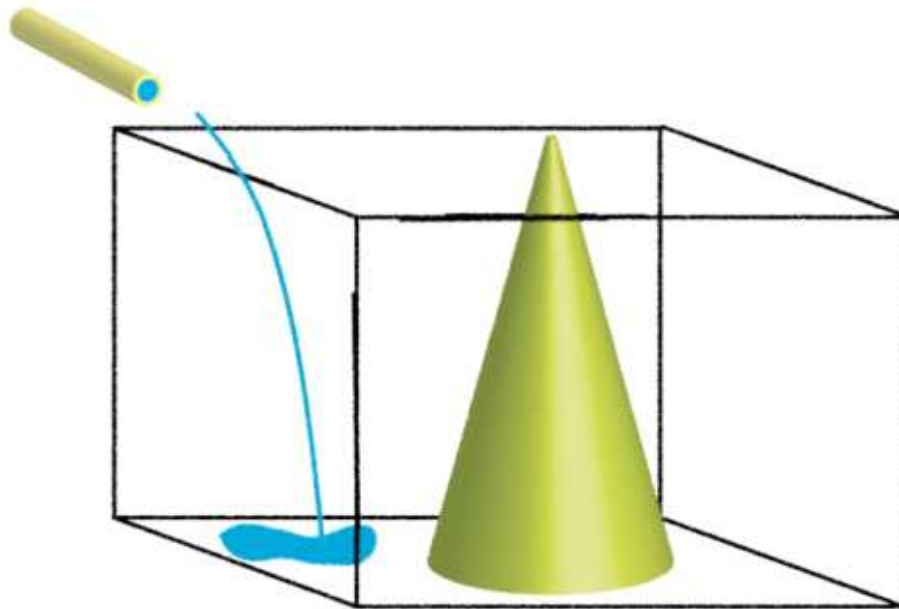
10% answered with the graph to the left



20% answered with the graph to the left



o Post-Test (Graphing Literacy)



40% drew the correct shape graph with correct explanations



Thank you for listening

