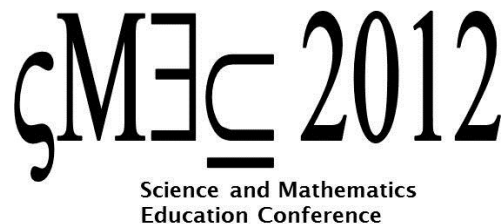


EFFECTIVE EVALUATION OF PHYSICS INSTRUCTION

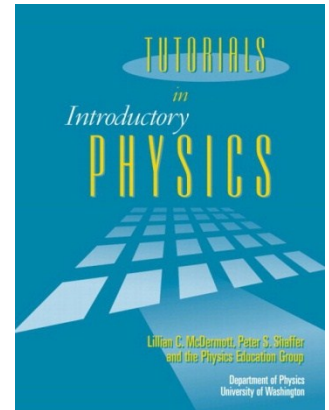
How pre-post testing and interviews can assess
student learning and guide the design of future
instruction

Leanne Doughty
Paul van Kampen
Eilish Mc Loughlin

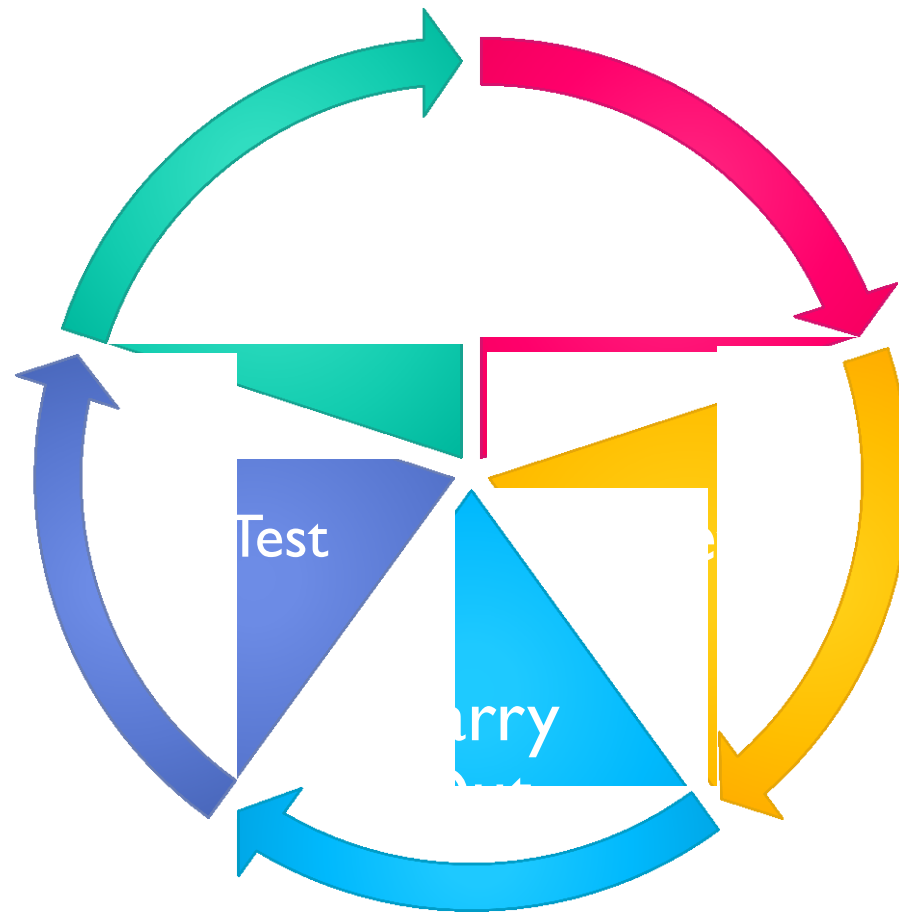


Background

- Electromagnetism and Waves and Optics
- Aim:
 - Develop a guided inquiry curriculum
 - Tutorial worksheets guide students through reasoning
 - Homework exercise to reinforce
- Conceptual tutorials adapted from or patterned after Tutorials in Introductory Physics
- Electromagnetism – mathematical tutorials
- Waves and Optics – simple harmonic motion tutorial



Curriculum Development



Effective Pre and Post Testing

- Pretests:
 - Specific

A point charge $+Q$ is placed a distance z_0 above the centre of a hypothetical circular disk with radius R located in the x, y -plane. Assume the disk's normal points downwards.

Is the electric flux $d\Phi_E$ through a small segment of length dr and angular width $d\phi$ located at (r, ϕ) is given by

A. $d\Phi_E = \frac{1}{4\pi\epsilon_0} \frac{Qrz_0}{(r^2 + z_0^2)^{3/2}} dr d\phi$.

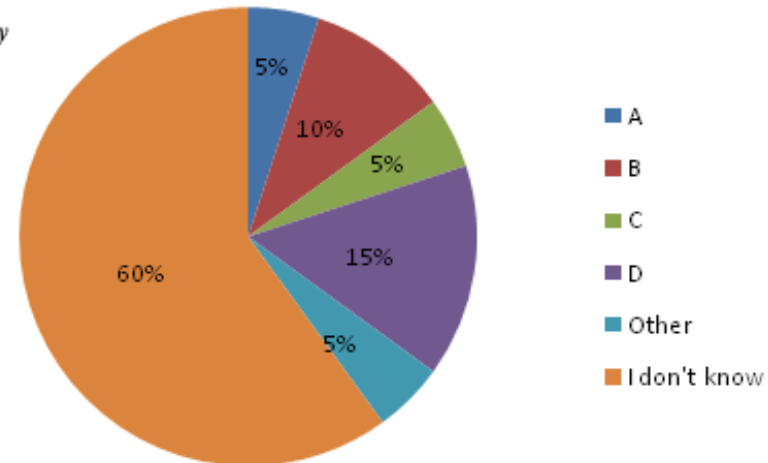
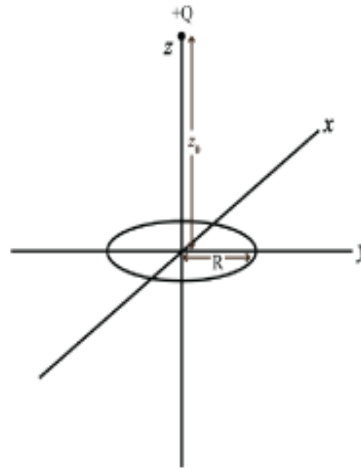
B. $d\Phi_E = \frac{1}{4\pi\epsilon_0} \frac{Qz_0}{(r^2 + z_0^2)^{3/2}} dr d\phi$

C. $d\Phi_E = \frac{1}{4\pi\epsilon_0} \frac{Qr}{r^2 + z_0^2} dr d\phi$

D. $d\Phi_E = \frac{1}{4\pi\epsilon_0} \frac{Q}{r^2 + z_0^2} dr d\phi$

E. Other

F. I don't know?



Effective Pre and Post Testing

- Pre-tests:

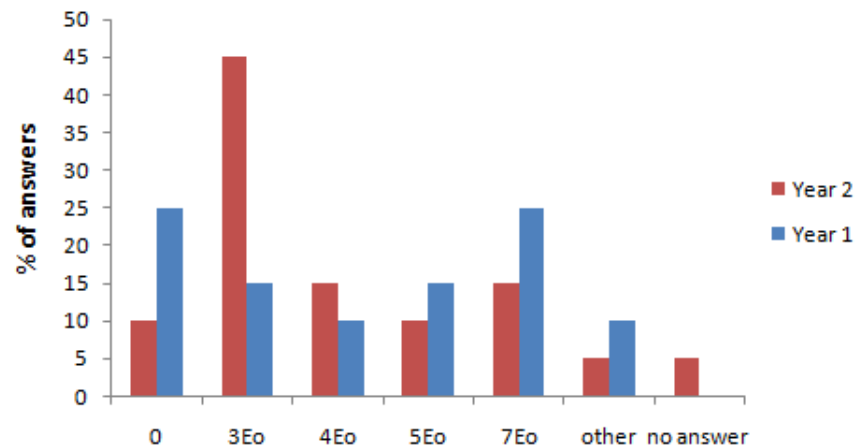
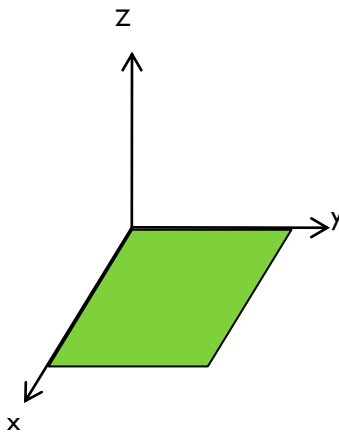
- Use results from one to influence the other

- Year One:

- Sheet in x,y - plane, $\vec{E} = 4E_0\hat{y} + 3E_0\hat{z}$
- Normal upwards, $\vec{E}\cdot\hat{n}$?
- Normal perpendicular to electric field
- Normal in y -direction

- Year Two:

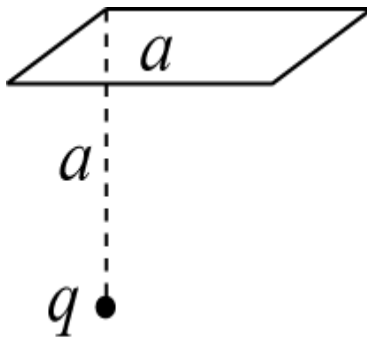
- Normal in z -direction
- Correct answers increase from 15% to 45%
- Suggests that visualisation is a difficulty



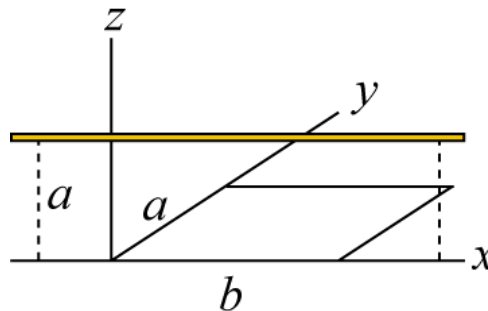
Effective Pre and Post Testing

- Post Tests:
 - Similar
 - Unseen
 - More difficult

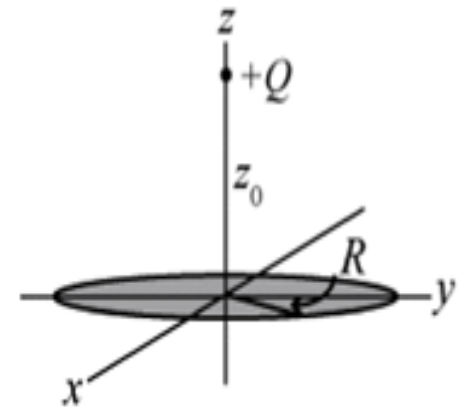
Tutorial



Homework



Post Test



Some Post Test Results

- Explain given expression for flux through small segment ($N=45$):
 - 30% correct
 - 25% no answer
 - All incorrect answers neglect a cosine (among other mistakes)
- Calculate flux through entire disk (from $d\phi \rightarrow \phi$)
 - 30% correct
 - 25% incorrect
 - 45% no answer

Implications of results

- Highlighted two main areas of difficulty:
 - Dot product
 - Integration
- Integration:
 - more testing – this time interpretation of integrals
 - new instruction specifically to tackle concept of integration
- Dot product:
 - student interviews
 - new work tutorial designed to introduce dot product

Student Interviews

- Teaching and learning interviews
- Semi-structured
- Work:
 - When is work positive, negative, zero?
 - Pen being moved across the table by my hand,
 - Work done by my hand?
 - Work done by friction?
 - Work done by gravity?

Findings from Student Interviews(N=10)

- 1 student correct for work done by the hand (kinetic energy reasoning)
- 4 students indicate that it depends on the direction that you take to be positive (only looking at one vector)
 - e.g. “ a lot of people will say its forward, so its positive”, “positive because on the x and y axis the y goes up the way”
- By gravity there is an even split in reasoning (5 kinetic energy, 5 force and displacement)

Implications for Instruction

A. Place your pen at rest on the table. Use your hand to give the pen some speed, then push the pen at constant speed, then let go of the pen.

1. Why does the pen come to a stop after you release it?

Is the change in the pen's kinetic energy *positive*, *negative*, or *zero*?

Is the work done on the pen *positive*, *negative*, or *zero*? Explain.

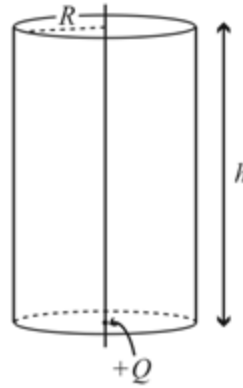
B. Draw arrows to indicate the directions of each force and displacement.

hand	friction	gravity

Comment on the relative directions of force and displacement when the work done is positive, negative and zero.

Have these changes had an impact

- Post test two:



- Explain given expression for flux through small segment ($N=62$):
 - 25% correct
 - 15% neglect a cosine
- Calculate flux through entire disk (from $d\phi \rightarrow \phi$)
 - 40% correct
 - 5% no answer
 - 10% nothing involving integration

Conclusion

- Combination of both pre and post testing and interviews
- Progress made
- Slow process
- Still a lot to be done!