



Designing and Assessing Learning Tutorials on Physics Integration Problems

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1. OBJECTIVES

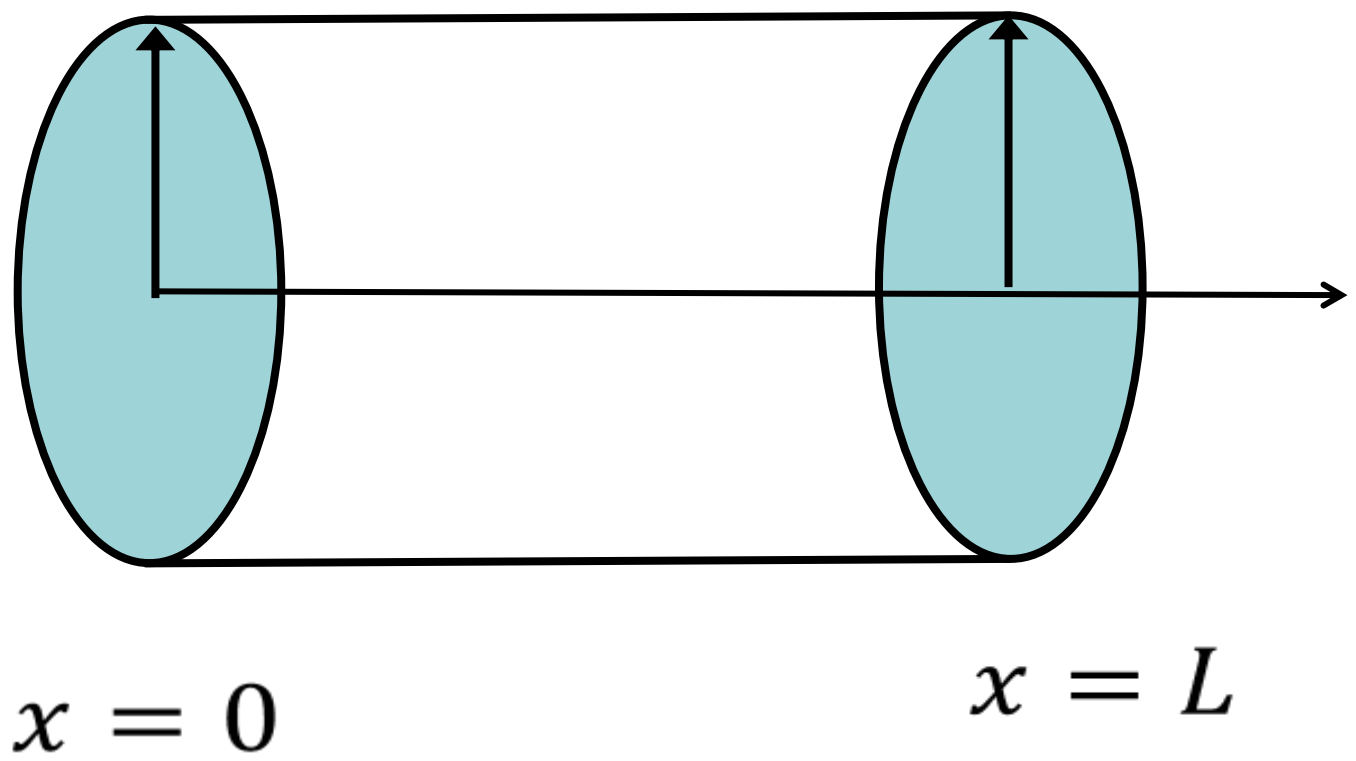
- Develop learning tutorial to target students' procedural and conceptual difficulties with setting up integrals in physics [1,2,3]
- Used a transfer task to assess students' ability to complete such problems after completing the tutorial

2. DATA COLLECTION

- 90 min tutorial session : pretest, intervention, paper-based test, online test
- Pedagogy is based on prescribed problem solving strategy [4,5]
- 31 students from a 2nd semester calculus-based physics course for engineers
- Students all had taken calculus of single-variables

3. LEARNING TUTORIAL

A cylinder of length L and cross sectional area A lies along the x -axis as shown. Its resistivity varies as $\rho(x) = \rho_0 \exp(-x/L)$. Find the total resistance of the cylinder.



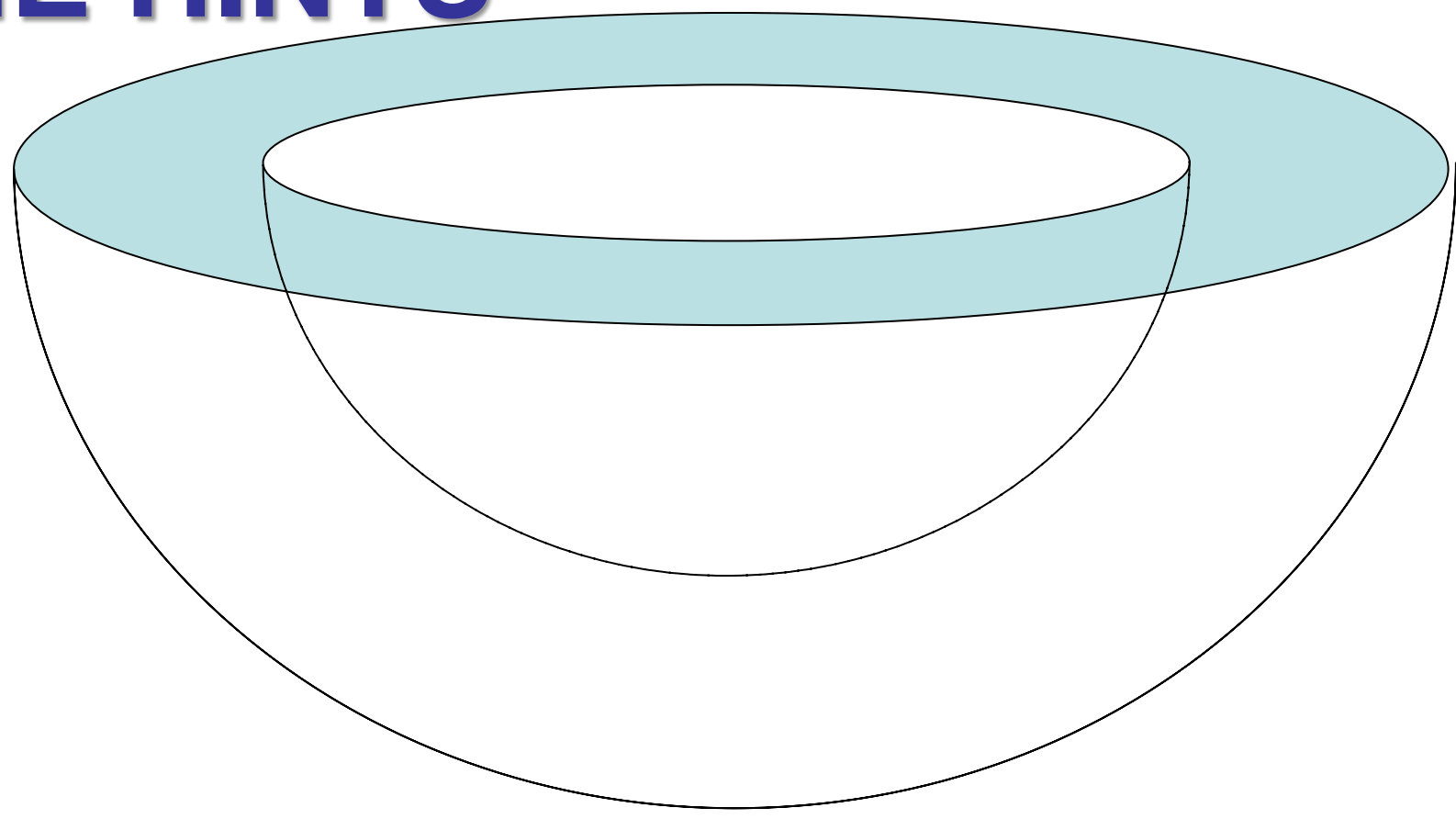
Steps	In each step...
Step 0: Recall related physics principles	Use words and/or pictures to explain your work.
Step 1: Chop the object	
Step 2: Find infinitesimal quantity	
Step 3: Find total quantity	
Step 4: Turn physics into mathematics	
Step 5: Computation	

7. REFERENCES

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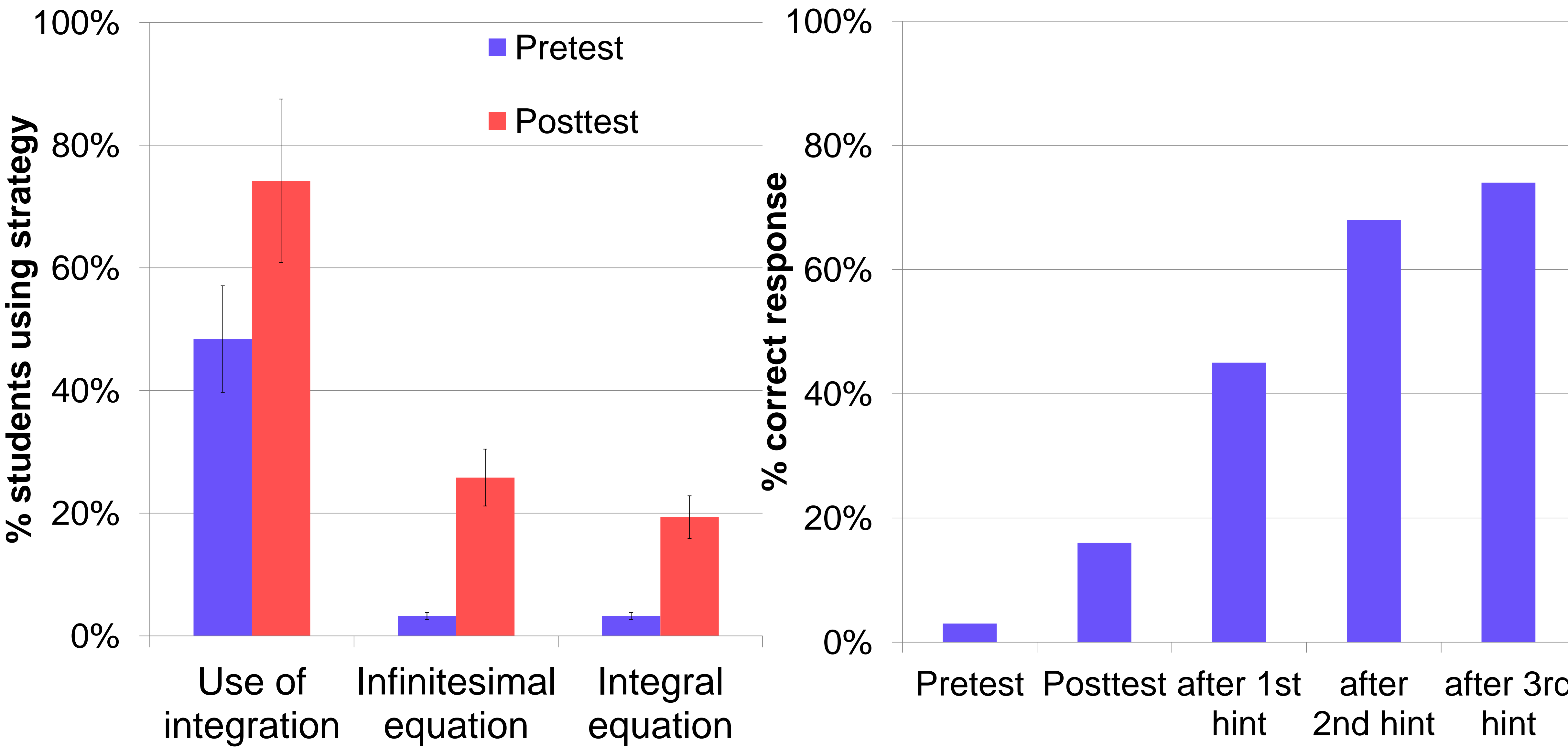
4. TRANSFER TASK & ONLINE HINTS

The region between two half concentric metal hemispheres of radii a and b is filled with a material whose resistivity varies with the radius as $\rho(x) = \rho_0 (r/b)$, where $a < r < b$. Find the resistance for the material between the two hemispheres.



Hint	1	2	3	4	5
Brief description	Visualizing the picture	Basic equation for resistance	Surface area of a sphere	Expression for dR	What to do next after expression of dR

5. RESULTS



6. CONCLUSIONS

- Our tutorial increased students' performance on the posttest transfer task but few students (<20%) were able to solve the problem correctly. The unfamiliar geometrical shape in the problem seemed to hinder the process of transfer.
- The online hints showed that students were able to solve the problem with appropriate guidance. The most commonly used hint by students was finding dR which seemed to cue students to visualize the hemispherical shell in terms of infinite number of infinitesimally thin shells.