

CAN ENGINEERING PRINCIPLES HELP TEACH PHYSICS?

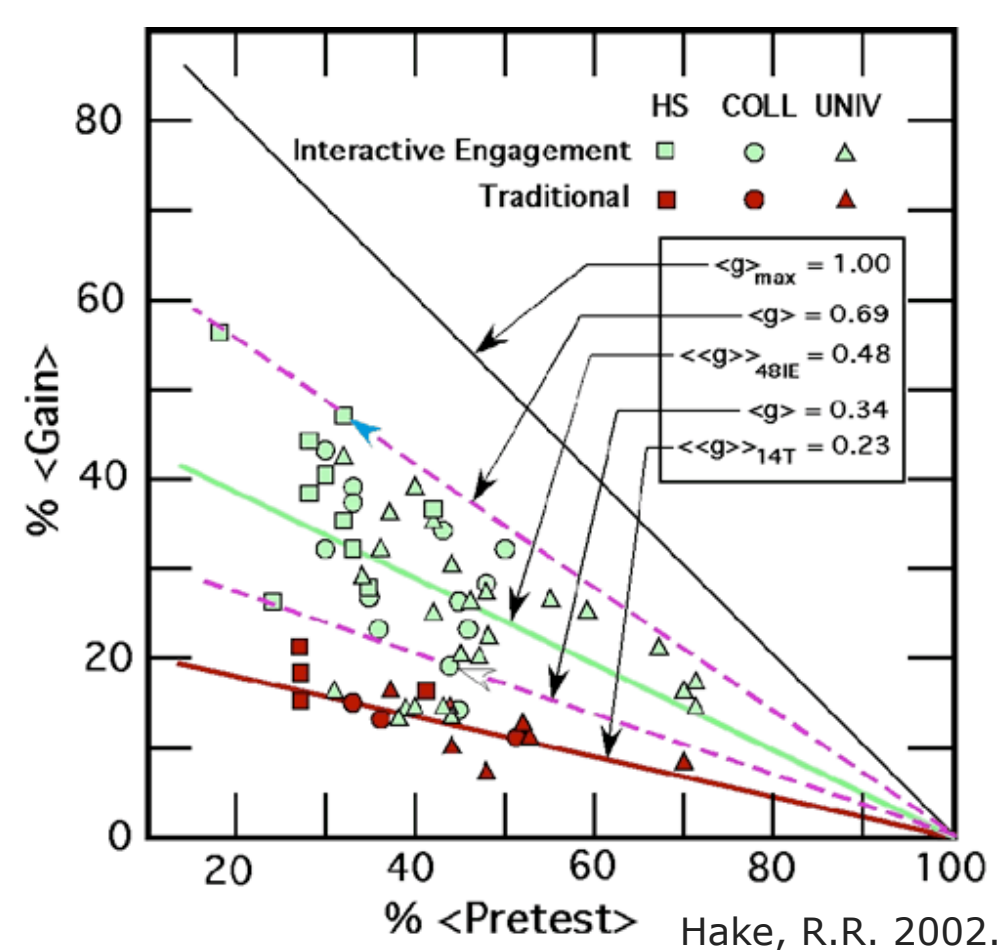
BACKGROUND

Physics Education Research (PER) has shown that physics students fail to understand basic Newtonian Mechanics after completing physics courses, irrespective of the proficiency of the teacher when using traditional lecture formats.

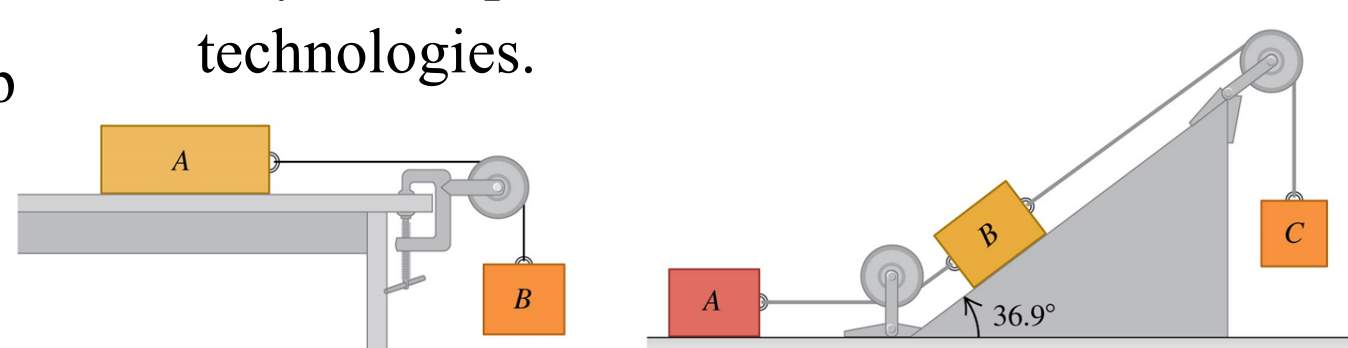
PER has shown that inquiry based tutorial methods result in greater conceptual understanding by students. Additionally, tutorial methods have shown to also improve student attitudes and motivations about physics.

CONCEPTUAL FRAMEWORK

Problem solving has long been notoriously difficult to teach. Many studies have sought to understand the problem with problem solving.



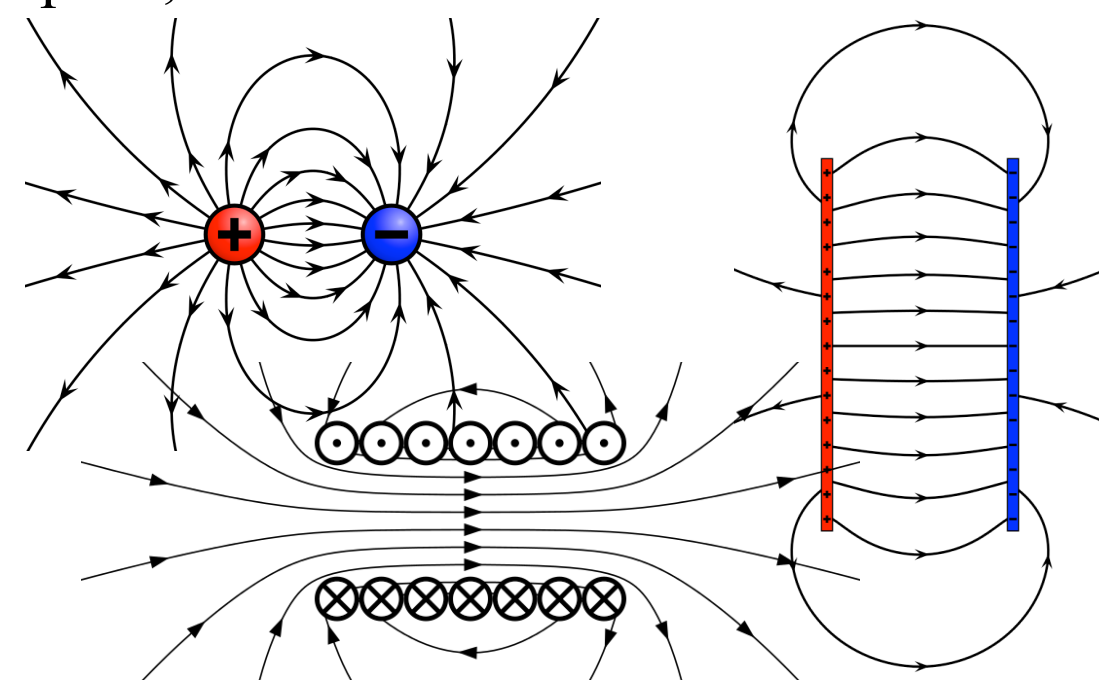
Through the use of tutorials, many students learn physics concepts more intuitively. Often referred to as interactive engagement, tutorials help the students teach themselves about the science involved in physics.



RESEARCH SETTING

Sheridan College is a community college in Northwest Wyoming.

The classes studied include Physics I & II covering kinematics, dynamics, statics, fluid mechanics, gravitation, thermodynamics, electromagnetism, and optics, with 7 students in each course.



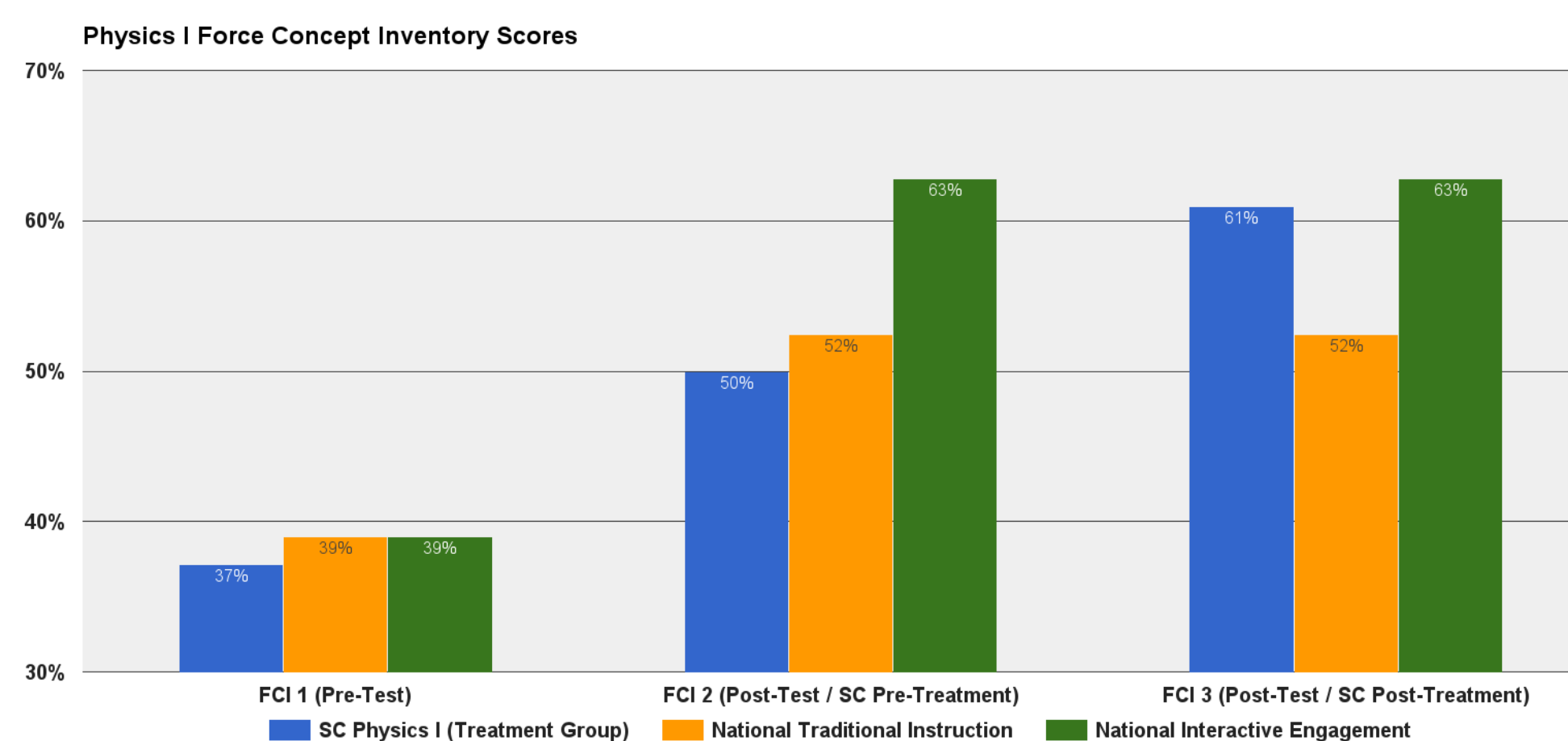
ADVANCED ENGINEERING TUTORIALS

After conducting traditional lecture based courses, the students were presented with engineering tutorials that were adapted from various PER sources, or newly authored material, as review for the final exam. The tutorials were designed for intuitive understanding by building on previous problems to show a logical progression.

The tutorials were developed using as graphical illustrations that were modeled symbolically. Design and optimization questions were analyzed with calculus or qualitatively. Sometimes multiple solutions were possible, and creativity was necessary. Finally, real-world applications were described.

The tutorials are designed to follow a deliberate problem progression leading to an understanding of engineering components, such as capacitors, solenoids, achromatic lenses, structures, or dynamic systems. Each step builds on the previous problem to show a logical progression.

The tutorials are almost completed almost entirely symbolically. Study of

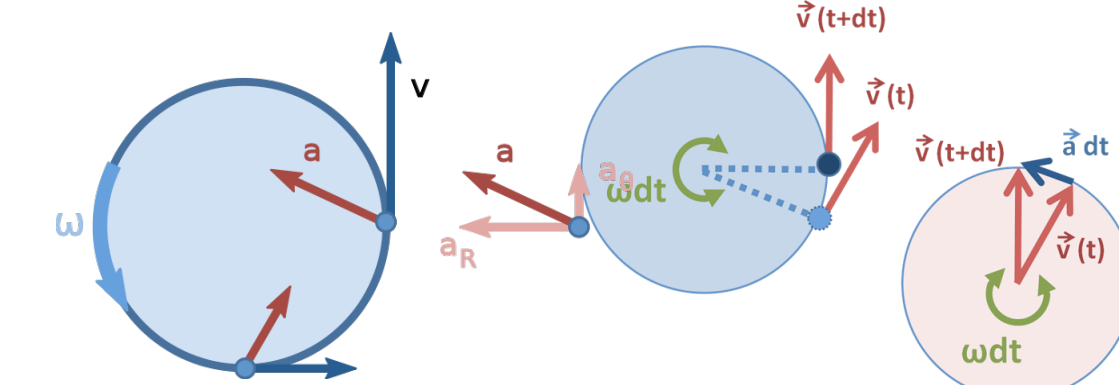
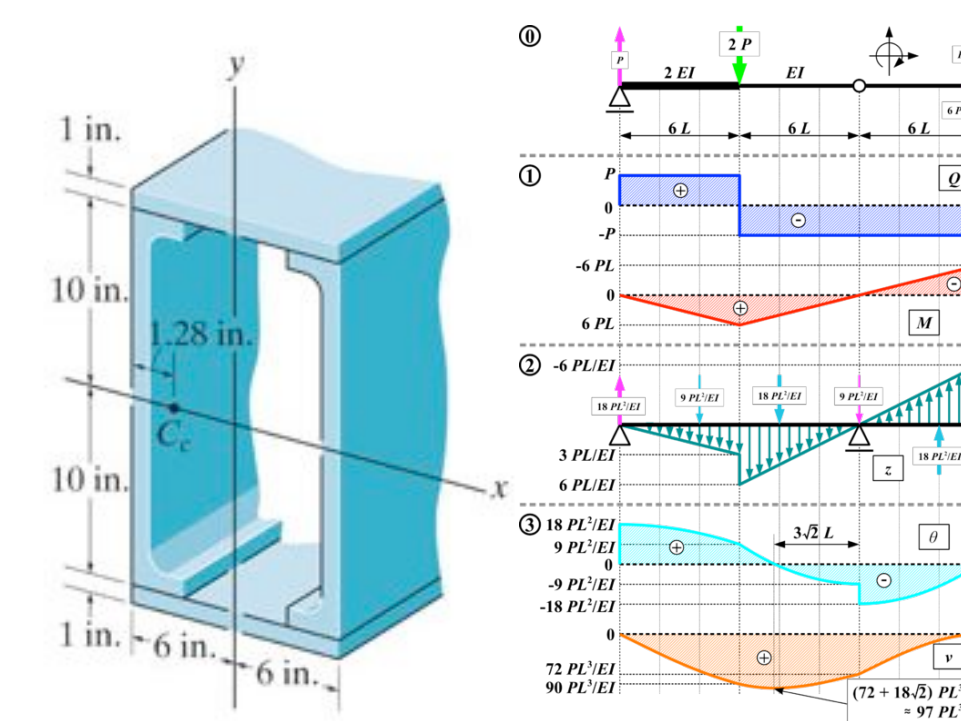


RESEARCH QUESTIONS

- Can engineering tutorials increase student conceptual physics knowledge?
- Can engineering tutorials improve student problem solving ability?
- Can engineering tutorials enhance student enjoyment of learning physics?

RESEARCH DATA TOOLS

- Force Concept Inventory (FCI)
- Brief Electricity and Magnetism Assessment (BEMA)
- Advanced Engineering Tutorial Student Feedback Survey (AETSFS)
- Student Coursework
- Instructor Observation



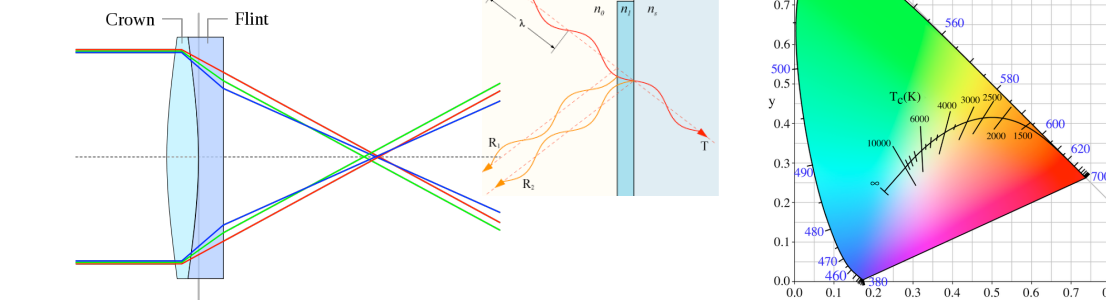
STUDENT PERFORMANCE

To quantify the effect of the engineering tutorials, conceptual tests were used to capture pre/post-treatment understanding. Student performance on overall coursework and student feedback was also considered.

FCI test gains for Physics I showed student performance similar to other traditional lecture courses pre-treatment, and post-treatment gains similar to other PER based courses. This demonstrated

that the short time invested in engineering tutorials made great gains during the review week for the final.

BEMA test gains for Physics II were not conclusive, but correlation data showed a relationship between increased gains and positive feedback on the engineering tutorials for lower achieving students.



PRIMARY REFERENCES

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