

Effects of the Order of Physical and Virtual Activities

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OBJECTIVE

Investigate how the order of using physical and virtual manipulatives affects students' understanding of physics concepts underlying pulleys as well as students' confidence in their understanding of these concepts.

INTRODUCTION

Previous Research: Virtual manipulatives (computer simulations) as effective as physical manipulatives (real experiments) in supporting student learning under some conditions. [1-4]

Research Questions

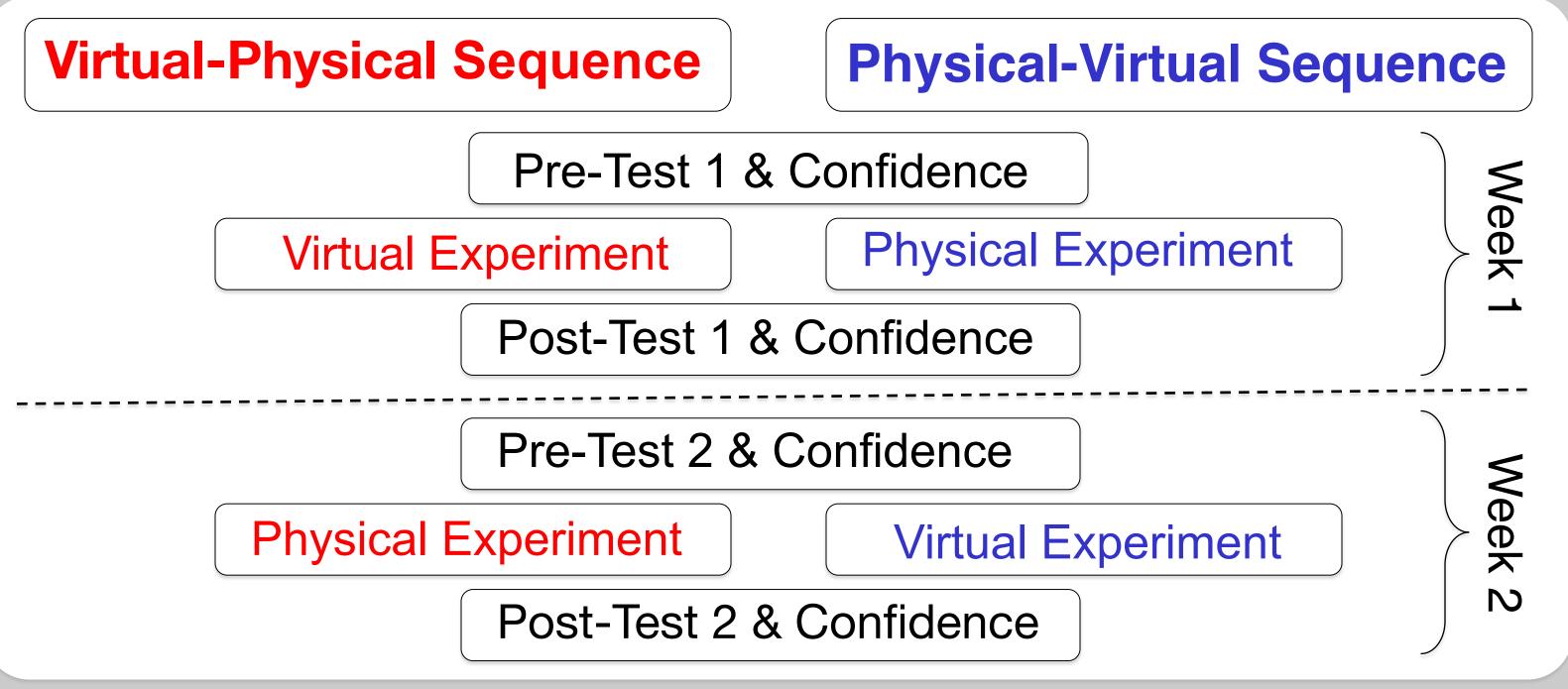
- •How does the temporal order of using physical and virtual manipulatives affect students' conceptual understanding of pulleys?
- •How do students' confidence in their test answers change as they use physical and virtual manipulatives?

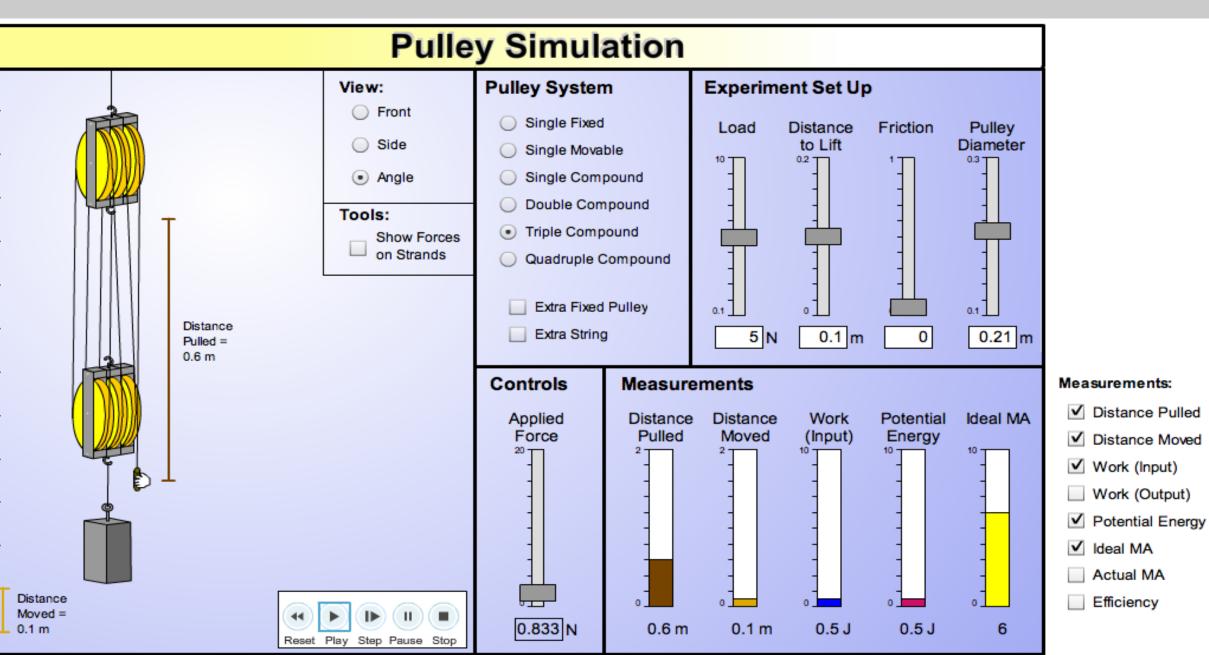
METHOD

Context: Conceptual physics lab, non-science majors

Curriculum: CoMPASS: Design-based, integrates concept maps & hypertext prior to physical or virtual experiments.

Data: Pre-test 1, post-test 1, pre-test 2 and post-test 2 scores: overall & question subsets, as well as 5-point Likert scale self-rating of confidence on each test.





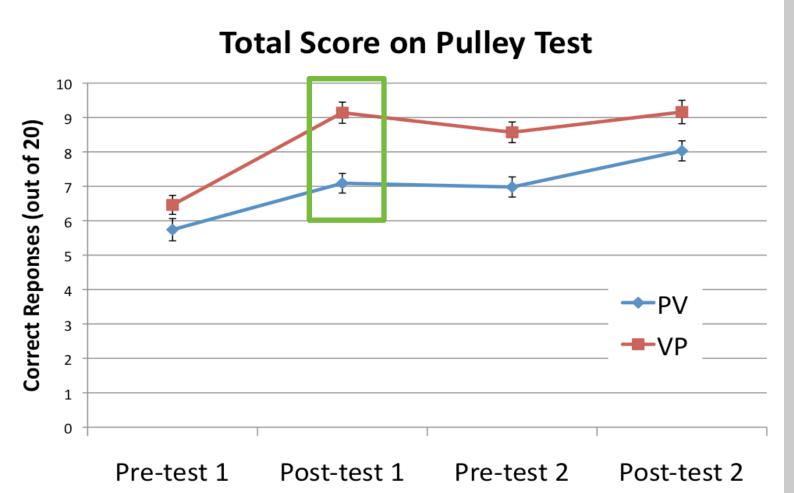
Computer simulation used for virtual experiment. Features dynamic bar charts and clickable measurement choices.

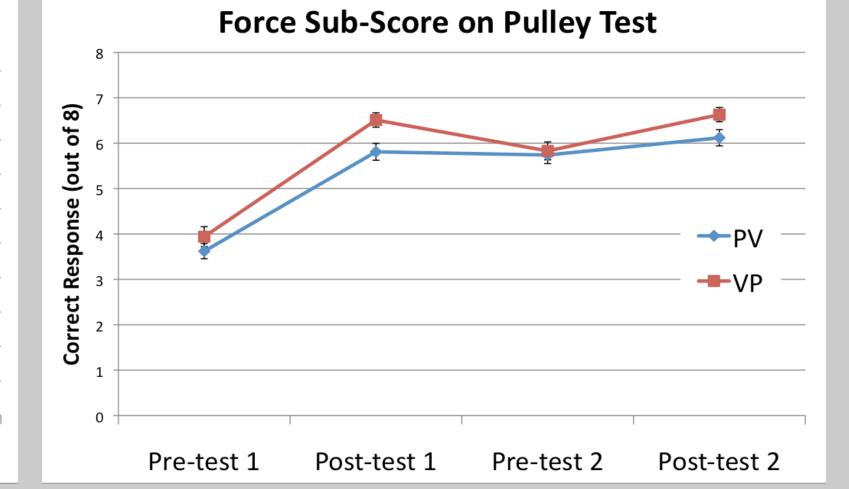
You can refer to the definition of work You can also read about work in other topics: Inclined Plane Wedge Wheel and Axle Screw Lever Work in Pulley A pulsey requires energy in order to do work. This energy is transferred by the force you apply when you pull on the pulley string. Pulleys can reduce the amount of applied force necessary to lift an object when doing work. The formula shows how work depends on both force and distance. The distance is how far you pull the string while exerting an applied force. When using a pulley, the amount of applied force needed to lift an object required to move a heavy object depends on the type of pulsey you use. Pulleys that decreases the amount of applied force needed to lift an object require that you pull the string a greater distance than the object rises. This trade-off between force and distance is called mechanical advantage (MA). As the rope moves through the pulley, the surface of the pulsey and the surface of the rope rub together and create friction. Friction is a force that decreases the afficiency of a pulley. If friction is present when you are doing work, you will need to increase the amount of applied force to overcome the friction force. Sometimes we are interested in how quickly work gets done. The faster you lift the object, the greater the power.

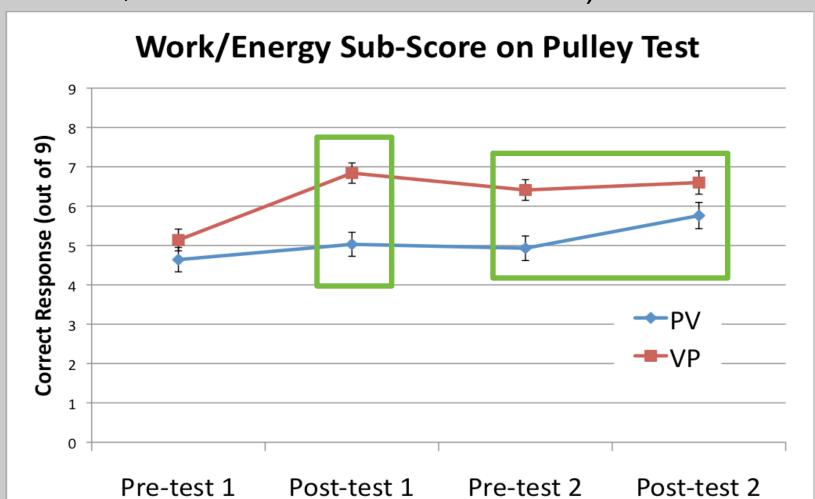
CoMPASS (Concept Mapped Project-based Activity Scaffolding System) hypertext environment with clickable "fish eye" concept maps and textual descriptions of concepts related to simple machines.

RESULTS

VP sequence: N=63, PV sequence: N=58 (*confidence data: N=42 for PV and N=47 for VP, due to data collection error)







Total Score

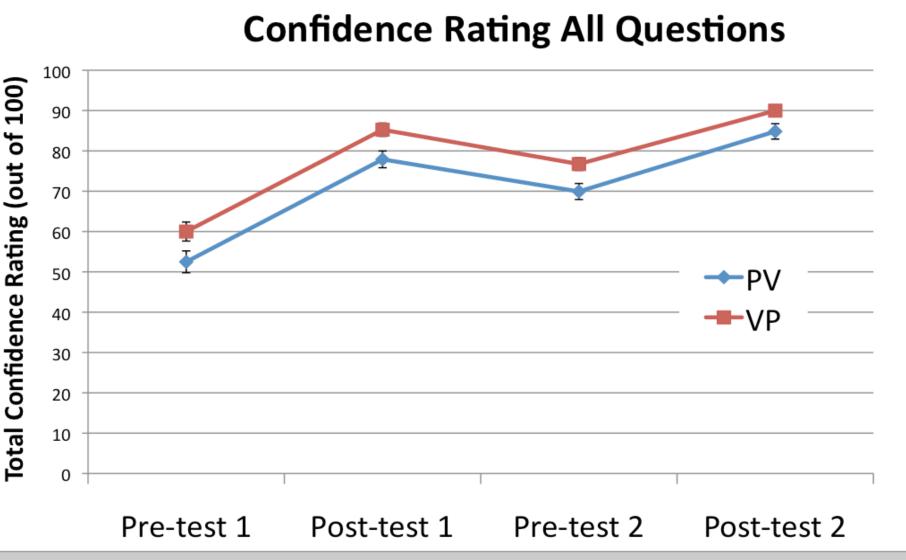
- VP students scored higher on post-test 1 (F (2.6, 223.3)=4.3, p=.008). Scores for both sequences changed similarly thereafter.
- No difference between pre-test 1 and post-test 2 based on sequence (F(1,87)=3.1, p=.082).

Force Concept

• No difference in test scores based on sequence.

Work/Energy Concept

- VP students scored significantly better on post-test 1 (F (2.6, 228.8)=5.1, p=.003).
- PV students made a steeper increase between pre-test 2 and post-test 2 (F(1,119)=6.3, p=.013).
- No difference between pre-test 1 and post-test 2 based on sequence.



Confidence Rating

- No difference in students' reported confidence based on sequence.
- Significant changes in confidence between each test.

CONCLUSION

Total Score: Students who perform the virtual experiment first (VP sequence) score higher on post-test 1. There is no difference in student learning from pre-test 1 to post-test 2 based on sequence.

Force Concept: Students learn about force equally well in both the PV and VP sequences.

Work/Energy Concept: Students learn the most about work and energy after performing the virtual experiment, regardless of sequence. The simulation presents an idealized (frictionless) situation which graphically displays the abstract quantities of work and potential energy. These features likely help students learn more.

Confidence: Student confidence in test answers improves from pre-test 1 to post-test 1, declines from post-test 1 to pre-test 2 and improves from pre-test 2 to post-test 2. Confidence ratings changed similarly for both sequences of experiments performed.

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