

HOW PHYSICAL AND VIRTUAL EXPERIMENTS INFLUENCE STUDENTS' UNDERSTANDING OF PULLEYS

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Research Questions

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- Do physical and virtual manipulatives offer different support for students' understanding of pulleys?
- Does the sequence in which students perform experiments with physical and virtual manipulatives affect students' understanding of pulleys?

Previous Studies

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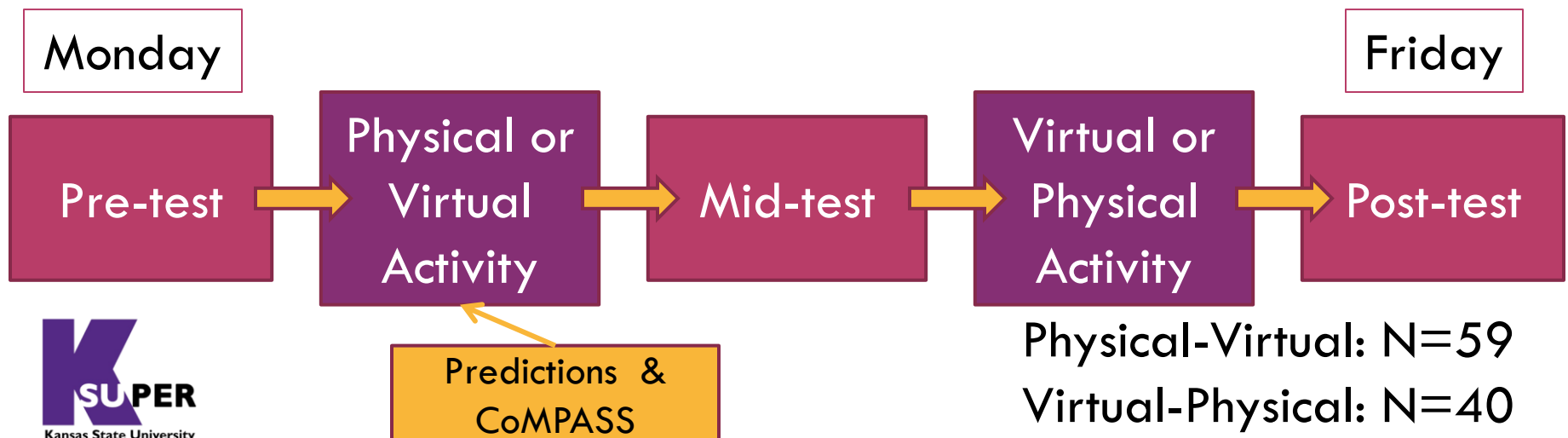
- Simulations may offer better support than physical equipment (Finkelstein *et al.*, 2005; Zacharia *et al.*, 2008)
- Simulations and physical equipment may offer equal support (Triona, Klahr & Williams, 2007; Zacharia & Constantinou, 2008)

- Our previous study (Gire *et al.*, 2010):
 - Physical manipulative and Physical-Virtual sequence offered better support for learning about *force*
 - Virtual manipulative offered better support for learning about *work*

Description of Current Study

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- Conceptual-based physics course for future elementary school teachers
- “Drop-in” style lab
- Students chose sequence of physical and virtual activities

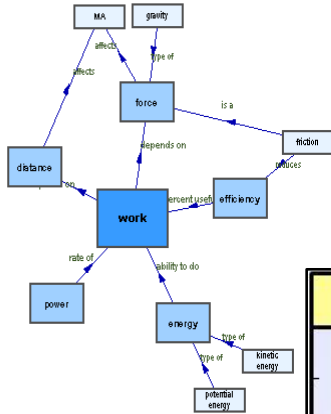


CoMPASS and Manipulatives

Change unit Change topic Go to: [Pulley](#) Search Go [History](#) [Logout](#)

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 **pulley** 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 for work is:

$$work = force \times distance$$

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 force required to move a heavy object depends on the type of pulley you use. Pulleys that decrease 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)**.

Pulley Simulation

View:

Front

Side

Angle

Pulley System

Single Fixed

Two Fixed

Single Movable

Single Compound

Double Compound

Triple Compound

Experiment Set Up

Load: N

Distance to Lift: m

Controls

Effort Force: N

Distance Pulled: m

Distance Moved: m

Work Done: J

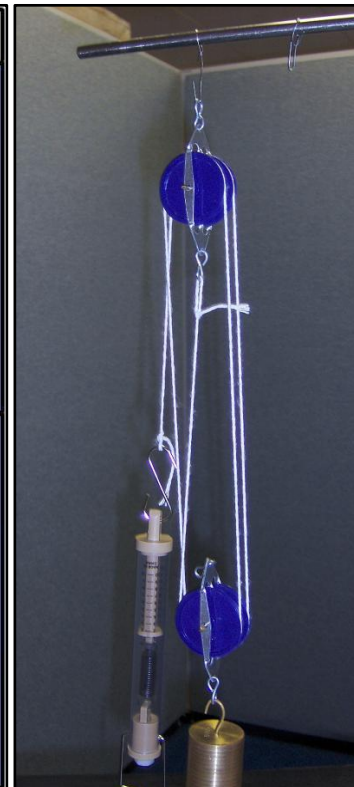
Distance Moved: m

Distance Pulled: m

Distance Moved: m

Work Done: J

Reset Play Step Pause Stop



Assessment

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- 20 multiple-choice questions
 - ▣ Force questions: 7
 - ▣ Work & Potential Energy questions: 9

- Cronbach's alpha = .743

- No significant difference in time from second activity to post-test for the two sequences, $t(97) = -.93$, $p = .357$

Total Score

7

Mixed ANOVA

Main Effect: $p < .001$

Interaction: $p = .976$

Pre-Mid

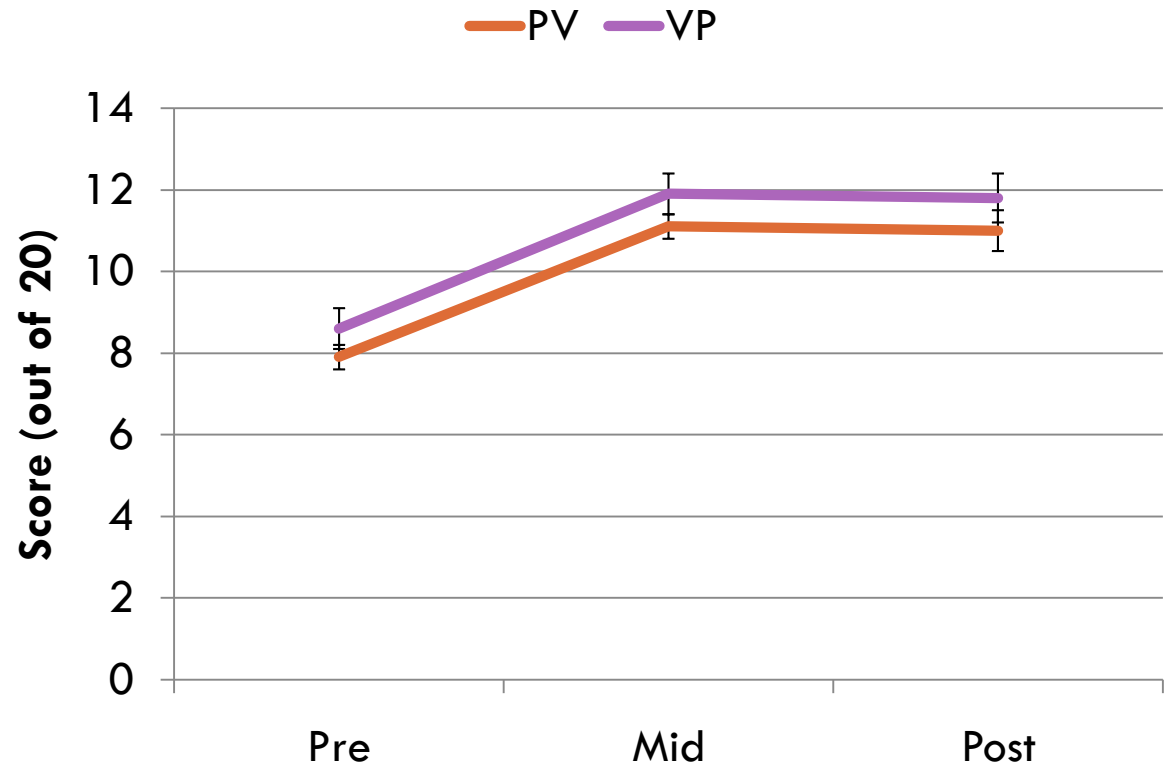
Main Effect: $p < .001$

Effect Size: $r = .72$

Mid-Post

Main Effect: $p = .702$

Effect Size: $r = .04$



Total Score equally supported by both manipulatives and both sequences

Force Score

8

Mixed ANOVA

Main Effect: $p < .001$

Interaction: $p = .147$

Pre-Mid

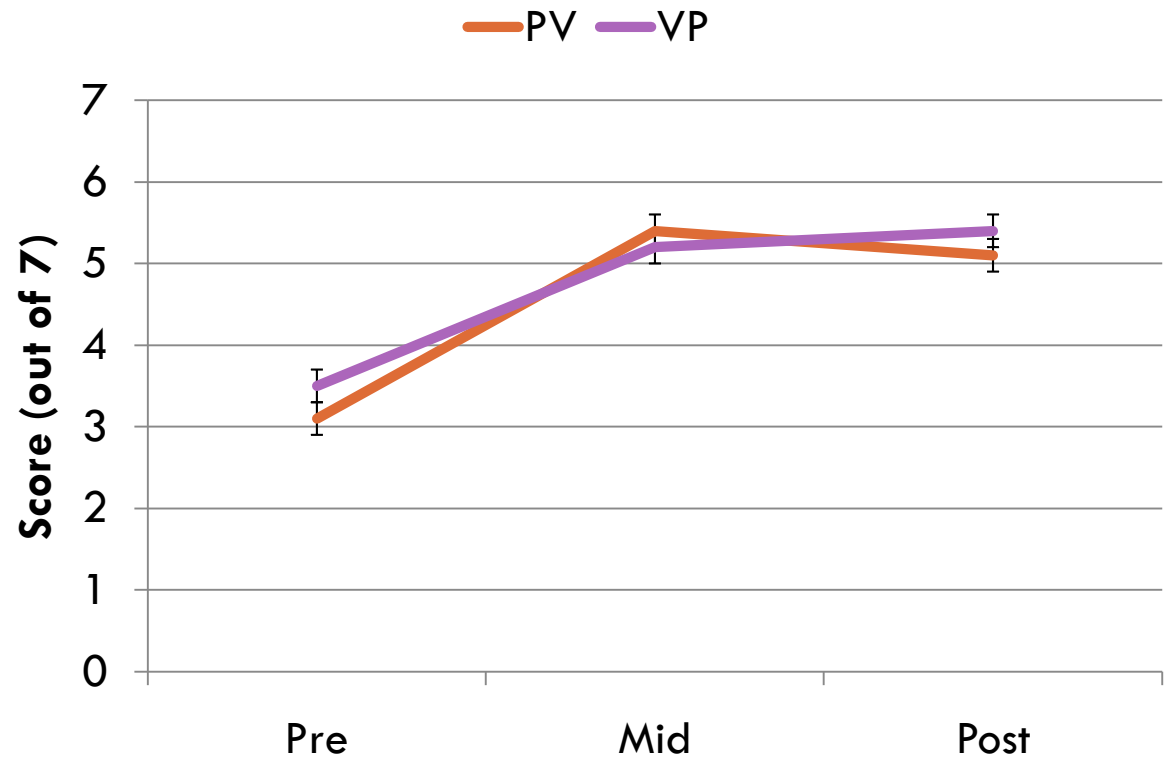
Main Effect: $p < .001$

Effect Size: $r = .78$

Mid-Post

Main Effect: $p = .575$

Effect Size: $r = .06$



Force Score equally supported by both manipulatives and both sequences

Work/Energy Score

9

Mixed ANOVA

Main Effect: $p=.520$

Interaction: $p=.020$

Pre-Mid

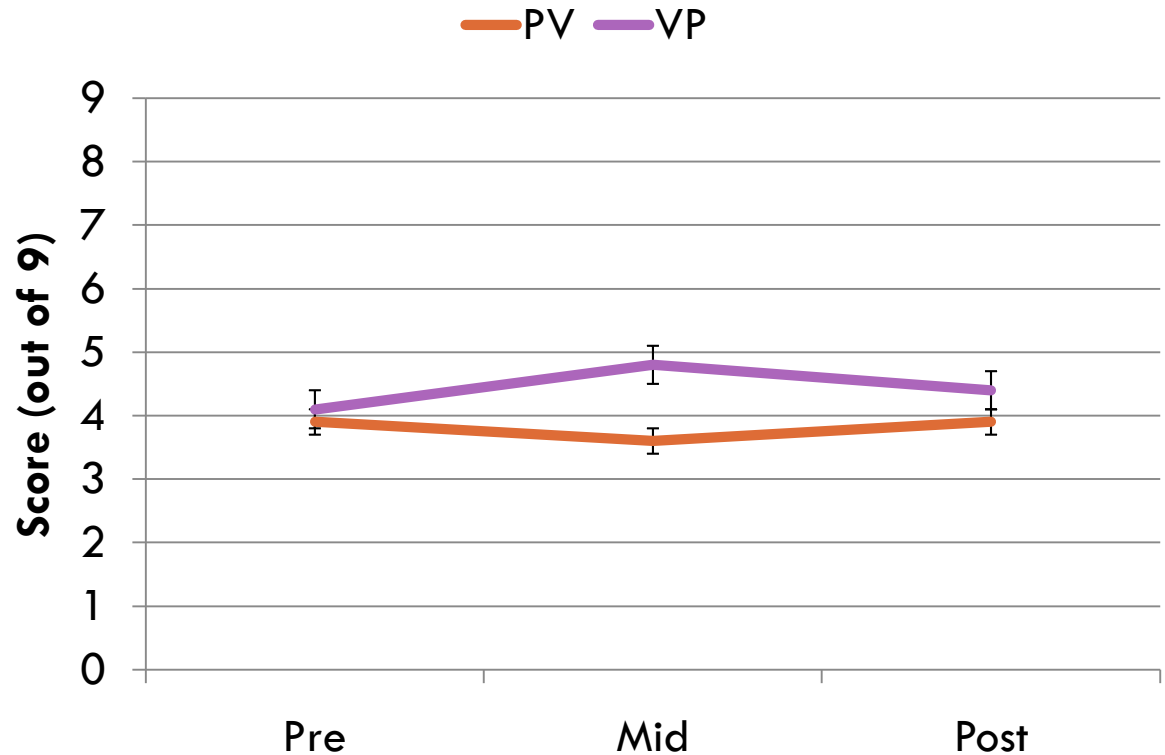
Interaction: $p=.009$

Effect Size: $r=.26$

Pre-Post

Interaction: $p=.702$

Effect Size: $r=.04$



Work score supported a little better by virtual manipulative but supported equally by both sequences

Discussion

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- In this study:
 - ▣ Work score is supported slightly better by simulation
 - ▣ Both sequences offer equal support for Total, Force & Work scores
- This does not match previous study. Why?
 - ▣ Different population
 - ▣ Different format (“drop-in” style lab)
 - ▣ Different questions
 - ▣ Different timing of test (Heckler & Sayre, 2010)

Thank you!

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