

Qualitative Analysis of the Effects of Sequence of Physical and Virtual Activities on Student Conceptual Understanding in Mechanics

Adrian Carmichael
Jacquelyn J. Chini, N. Sanjay Rebello
Kansas State University

Sadhana Puntambekar
University of Wisconsin,
Madison



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Research Questions

- How does the temporal order of physical and virtual experiments affect students' understanding?
- How do students react to anomalous experimental data from physical and virtual experiments?

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Previous Research

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- Zacharia, Olympiou, & Papaevipidou (2008)
- Heat and temperature lab
- Group 1 used physical manipulatives
- Group 2 used physical then virtual manipulatives
- Results: Group 2 performed better on a conceptual test

Theoretical Framework

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Responses of Students to Anomalous Data:

- Ignore
- Reject
- Exclude from the domain
- Hold in abeyance
- Reinterpret and retain
- Reinterpret data and make peripheral changes
- Accept and change theory

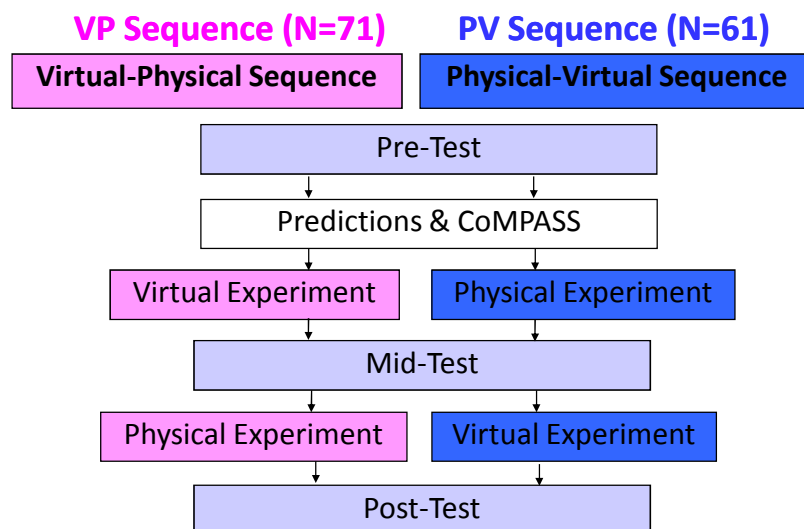
Chinn, C., & Brewer, W (1993). *Review of Educational Research*, 63, 1-49.

Factors That Affect Response to Anomalous Data ⁵

1. Prior knowledge
2. Processing Strategy
3. **Characteristics of Data**
 - Credibility
 - **Ambiguity**

Chinn, C., & Brewer, W (1993). *Review of Educational Research* , 63, 1-49.

Experimental Design ⁶



CoMPASS Interactive Concept Maps

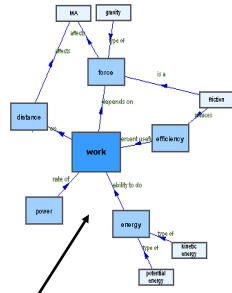
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Change unit Change topic Go to: Pulley Search

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](#)

Concept in several contexts



Dynamic "fish eye" concept maps

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 \(MA\)](#).

As the rope moves through the pulley, the surface of the pulley and the surface of the rope rub together and create friction. Friction is a force that decreases the [efficiency](#) 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](#).

Links in body of text

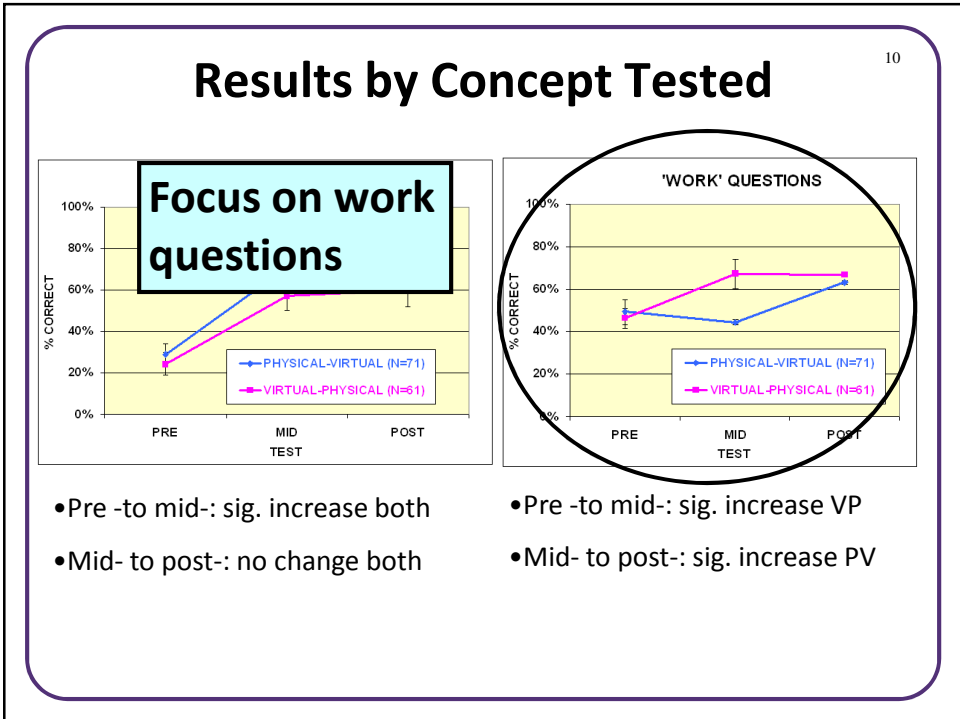
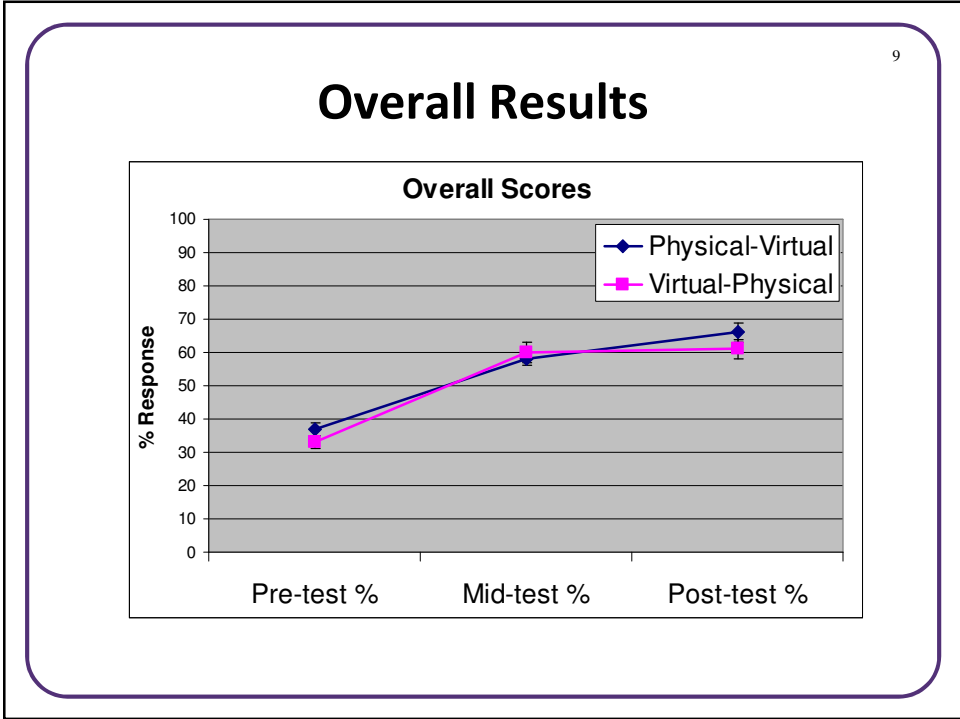
Physical and Virtual Manipulatives

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Pulley Simulation

Pulley System		Experiment Set Up	
<input type="radio"/> Single Fixed	<input type="radio"/> Two Fixed	Load: 4.9 N	Distance to Lift: 0.1 m
<input type="radio"/> Single Movable	<input type="radio"/> Single Compound		
<input checked="" type="radio"/> Double Compound	<input type="radio"/> Triple Compound		

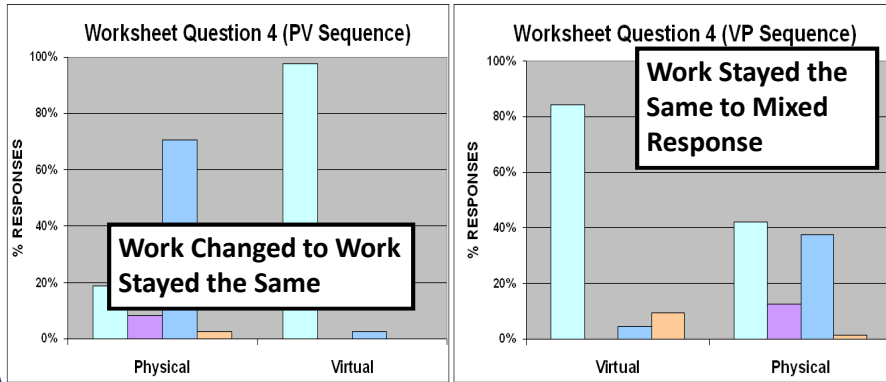
Controls			Measurements		
Effort Force: 1.225 N	Distance Pulled: 0.4 m	Distance Moved: 0.1 m	Work Done: 0.49 J		



Worksheet Question About Work

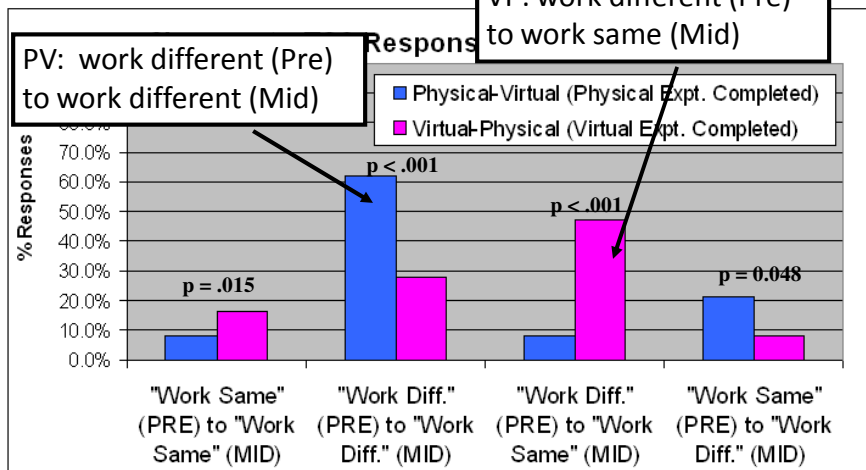
•Worksheet Question 4: “Based on your data, when you changed the pulley setup, how did it affect the work required to lift the object? Why do you think that is?”

- work stayed same
- work changed
- work changed slightly
- other



Changes in Answers on Test Q 9

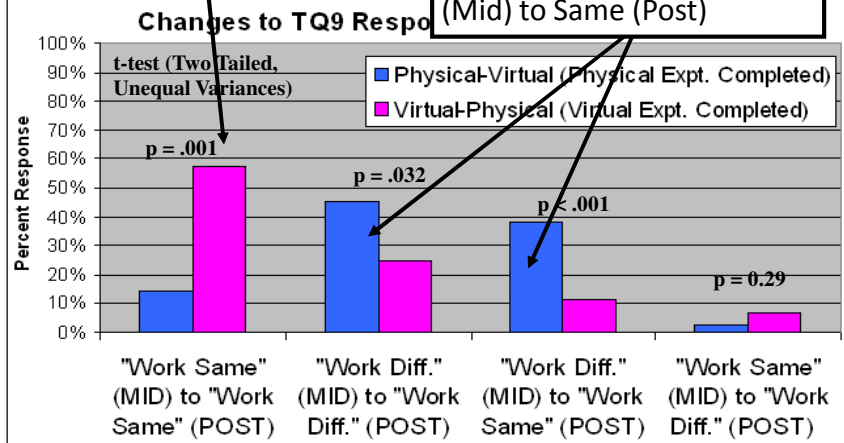
Pre- to Mid



Changes in Answers on Test Q 9 ¹³

VP: same (Mid) to same (Post)

PV: either different (Mid) to different (Post) OR Different (Mid) to Same (Post)



Factors That Affect Response to Anomalous Data ¹⁴

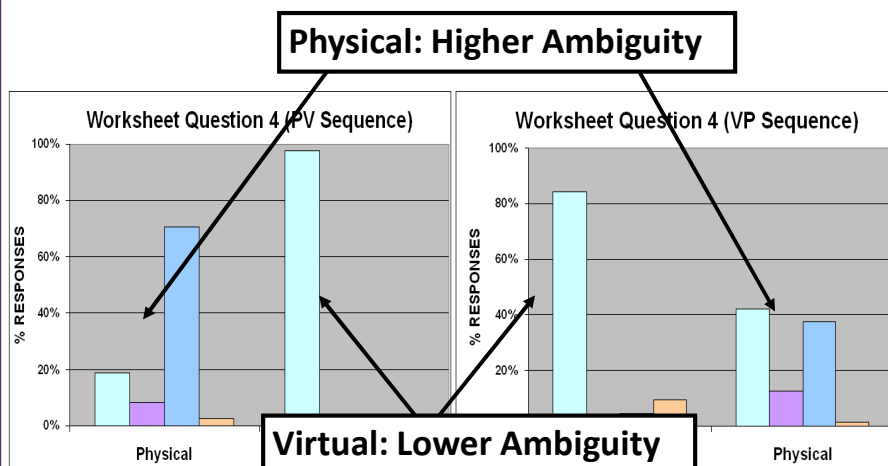
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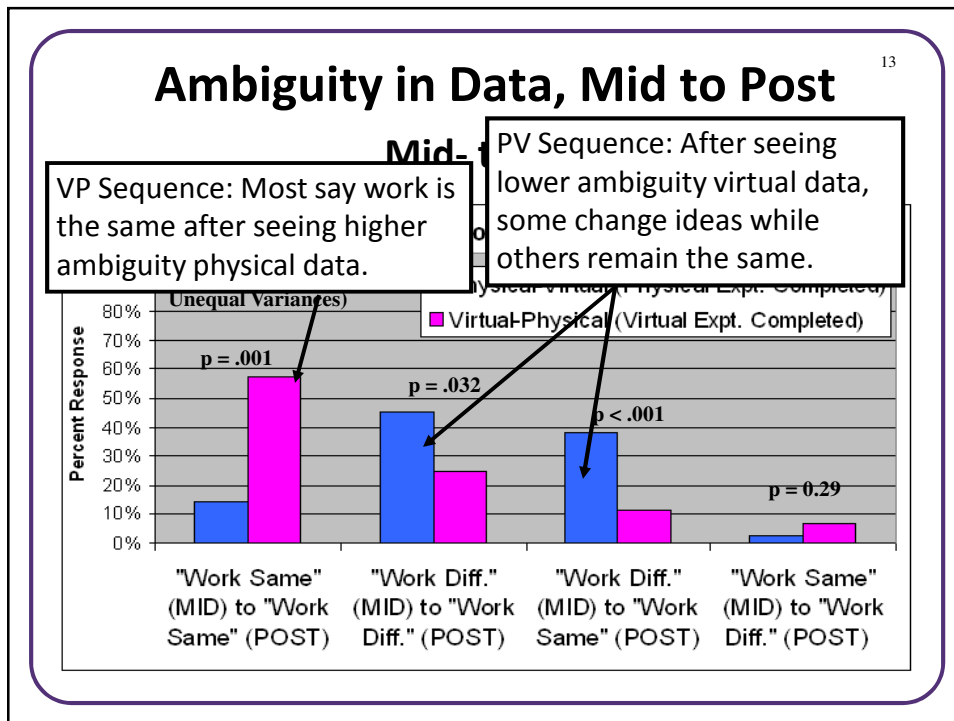
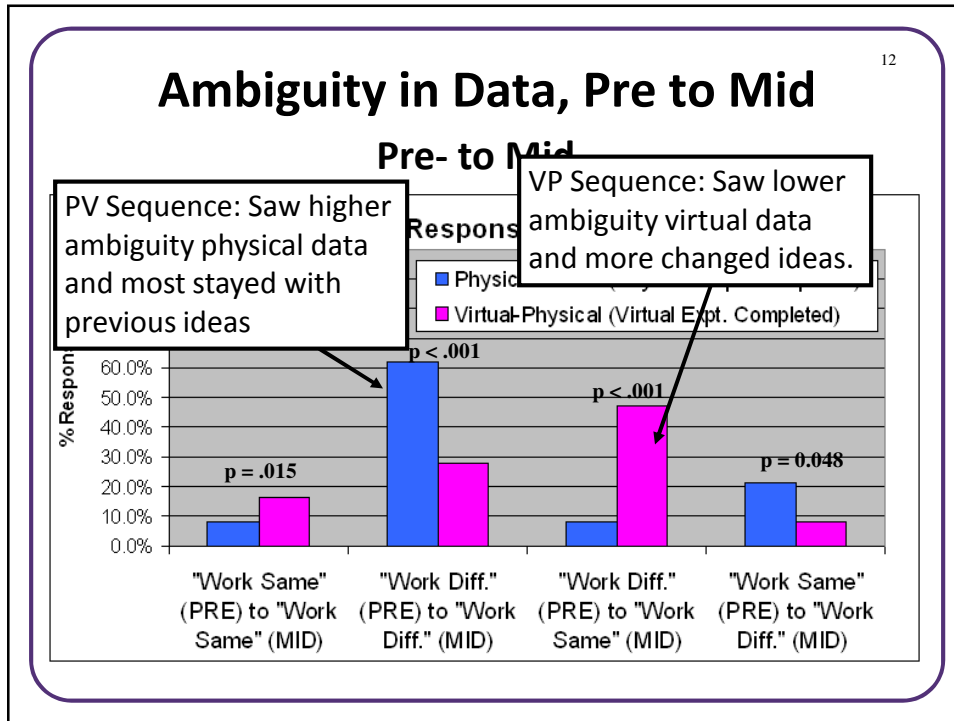
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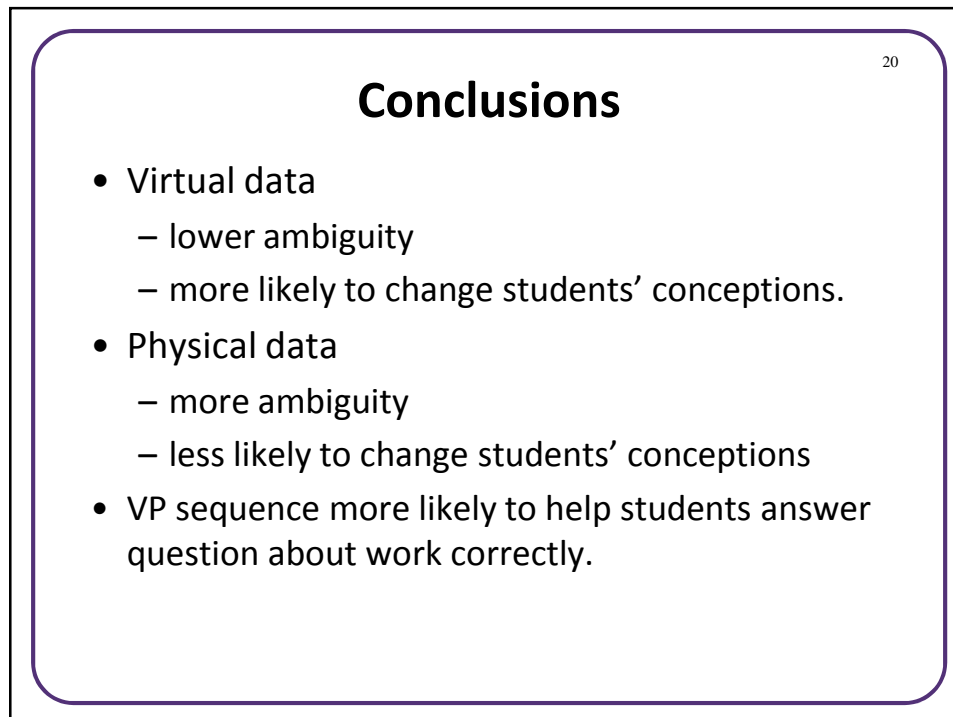
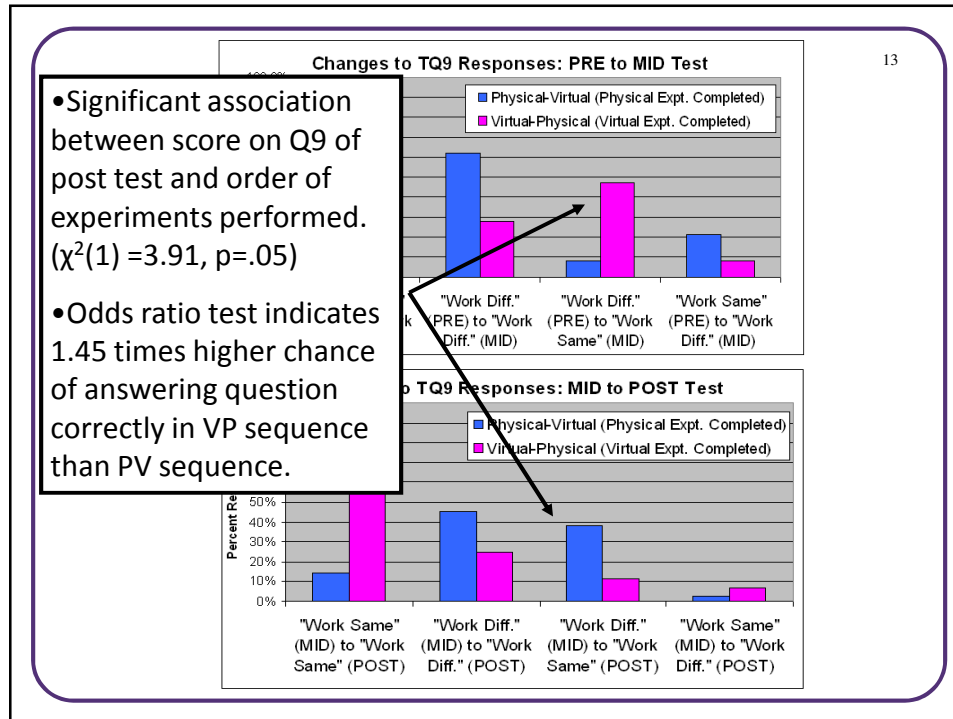
Sample Data

	Work value measured in PHYSICAL experiment	Work value measured in VIRTUAL experiment
Single Fixed	.49 J	.50 J
Single Movable	.52 J	.50 J
Single Compound	.38 J	.50 J
Double Compound	.54 J	.50 J

Ambiguity in Data







Future Work

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- Confidence ratings
- Epistemological survey
- Explanation on test answers