

Students' Views of Data Collected from Physical and Virtual Manipulatives

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JACQUELYN CHINI

ELIZABETH GIRE, ADRIAN CARMICHAEL & N. SANJAY REBELLO-
KANSAS STATE UNIVERSITY

SADHANA PUNTAMBEKAR-
UNIVERSITY OF WISCONSIN, MADISON



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Background

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- Several studies have looked at how students' learning is supported by physical and virtual manipulatives
 - Circuits: Finkelstein *et al.*, 2005
 - Mechanics, Heat & Temperature, Optics, Waves & Circuits: Zacharia *et al.*, 2003, 2005, 2007 & 2008
- Our research: simple machines
 - Inclined Planes: frictionless environment made possible by virtual manipulatives may support students' learning
 - Pulleys: Physical manipulatives may better support learning about distance pulled, force & mechanical advantage, while virtual manipulatives may better support learning about work

Research Questions

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- Goal: Examine this issue from students' point of view
- We ask, what views do students express about data collected from physical and virtual manipulatives?
 - Which set of data is more useful in particular situations?
 - ✦ Different contexts
 - ✦ Different concepts
 - ✦ Different pulley systems
 - How is the data collected from these two sources similar and different? (poster tonight)

Study Design

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- Used CoMPASS (Concept Mapped Project-based Activity Scaffolding System) pulley curriculum (Puntambekar, *et. al*, 2005)
- 101 students enrolled in a conceptual-based physics course for future elementary school teachers
 - Students performed activities with physical and virtual manipulatives in Activity Center
 - After completing activities, students responded to a survey in class
 - Students received extra credit for completing the survey

Physical and Virtual Manipulatives

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Pulley Simulation

Sample Question

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Q1) On a test, your professor has asked you some questions about several pulley setups.

A) On the first question on the test, you have to decide whether a **fixed** or **movable** pulley requires the least effort force to lift the load.

Which experience in the Activity Center would better help you answer this question? (Check **one**)

- Experiment with real pulleys Computer simulation of pulleys
 Both are equally helpful

➤ Explain what led you to make the choice above.

Survey Design

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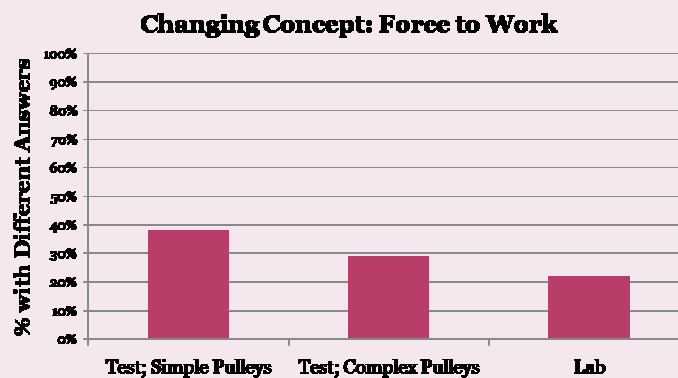
Question	Context	Variable	Pulley Systems
1	Exam	Force	Fixed & Movable
2	Exam	Work	Fixed & Movable
3	Exam	Force	Movable & Double Compound
4	Exam	Work	Movable & Double Compound
5	Rental Store	Not specified	Fixed & Movable
6	Rental Store	Not specified	Movable & Double Compound
7	Missed Lab	Force	Not specified
8	Missed Lab	Work	Not specified

- Two versions

Changing Concept: Force to Work

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In the same context and with the same pulley systems, when asked about **force** and **work**, how many students switch the type of manipulative they would like to use?



22-38% of students gave different answers to similar questions about force and work

Changing Pulley Setup

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In the same context and asked about the same variable, how many students switch the type of manipulative they would like to use when the pulley system becomes more complex?

Changing Pulley Setup: Simple to Complex

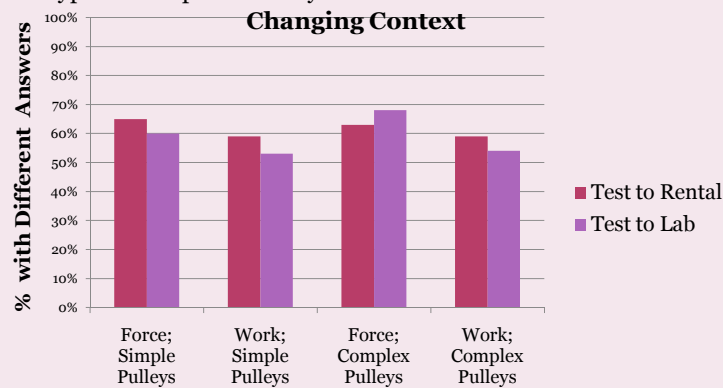


20-30% of students gave different answers to similar Q's about different pulley systems

Changing Context

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When asked about the same variable and pulley systems, how many students change the type of manipulative they would like to use when the context changes?

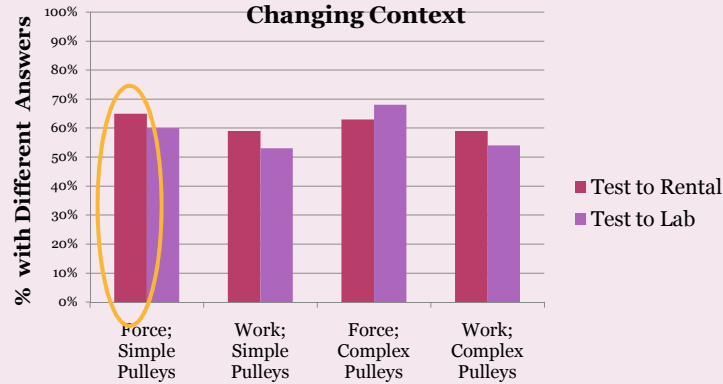


53-68% of students gave different answers to similar Q's about different contexts

Changing Context

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When asked about the same variable and pulley systems, how many students change the type of manipulative they would like to use when the context changes?



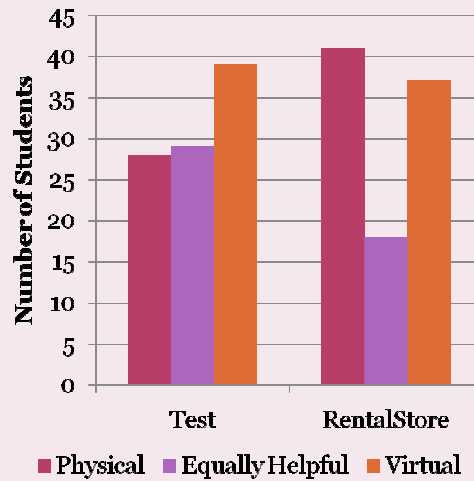
53-68% of students gave different answers to similar Q's about different contexts

Students' Responses

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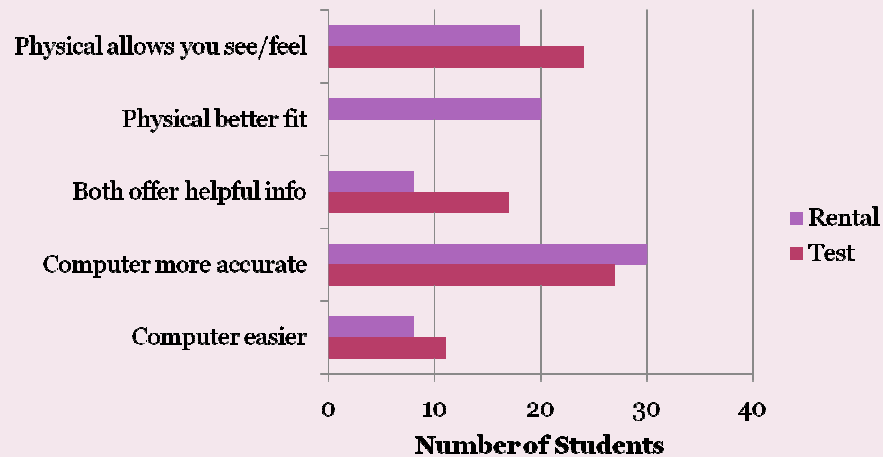
Which set of manipulatives would you use to decide:

- On a **test**, whether a fixed or movable pulley requires less force?
- In a **rental store**, whether a fixed or movable pulley will better help you lift a bed?



Students' Reasoning

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Results

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- Students most likely to change their answer when the context changes
 - 22-38% changed answer when **concept** changed
 - 20-30% changed answer when **pulley setup** changed
 - 53-68% changed answer when **context** changed
- On a specific question, students most often chose...
 - **Virtual** for “Test” context
 - **Physical** and **Virtual** for “Rental Store” context
- Students’ reasoning reveals understanding that...
 - Simulation data is free from certain types of errors
 - Physical provides more kinesthetic experience
 - Physical may be a better fit to a real life situation

Thank you!

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For more information, please contact:
Jackie Chini: haynicz@phys.ksu.edu
Sanjay Rebello: srebello@phys.ksu.edu