Students’ Views of Data Collected from Physical and Virtual Manipulatives

Jacquelyn Chini
Elizabeth Gire, Adrian Carmichael & N. Sanjay Rebello-Kansas State University
Sadhana Puntambekar-University of Wisconsin, Madison

This work is supported in part by U.S. National Science Foundation under the GK-12 Program (grant) (NSF DGE-0841414, P.I. Ferguson) and U.S. Department of Education, Institute of Education Sciences Award R305A080507.

Background

- Several studies have looked at how students’ learning is supported by physical and virtual manipulatives
  - Circuits: Finkelstein et al., 2005

- 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

- 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

- 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
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

<table>
<thead>
<tr>
<th>Question</th>
<th>Context</th>
<th>Variable</th>
<th>Pulley Systems</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Exam</td>
<td>Force</td>
<td>Fixed &amp; Movable</td>
</tr>
<tr>
<td>2</td>
<td>Exam</td>
<td>Work</td>
<td>Fixed &amp; Movable</td>
</tr>
<tr>
<td>3</td>
<td>Exam</td>
<td>Force</td>
<td>Movable &amp; Double Compound</td>
</tr>
<tr>
<td>4</td>
<td>Exam</td>
<td>Work</td>
<td>Movable &amp; Double Compound</td>
</tr>
<tr>
<td>5</td>
<td>Rental Store</td>
<td>Not specified</td>
<td>Fixed &amp; Movable</td>
</tr>
<tr>
<td>6</td>
<td>Rental Store</td>
<td>Not specified</td>
<td>Movable &amp; Double Compound</td>
</tr>
<tr>
<td>7</td>
<td>Missed Lab</td>
<td>Force</td>
<td>Not specified</td>
</tr>
<tr>
<td>8</td>
<td>Missed Lab</td>
<td>Work</td>
<td>Not specified</td>
</tr>
</tbody>
</table>

- Two versions

Changing Concept: Force to Work

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

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?

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

Changing Context

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

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

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

- Physical allows you see/feel
- Physical better fit
- Both offer helpful info
- Computer more accurate
- Computer easier

Results

- 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!

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