Simulations can be more affordable, safer and more accessible than physical experiments. These virtual manipulatives may affect how students evaluate new knowledge and choose between learning experiences supported by physical and virtual manipulatives.

Students may or may not be enrolled in the lecture section of the course (Puntambekar, et al. 2003). Students used real pulleys or the computer simulation of pulleys after engaging in each activity. Students select a pulley system and adjust the load, distance lifted and effort force with sliders. The load is lifted and the distances and work are dynamically displayed. Students select the most useful manipulative if the context map or as a hypertext link in the text. Students then completed an open-ended survey designed to explore their views about data collected from both manipulatives. The responses fell into the following categories. Chi-square goodness of fit test was significant at p<.001 for all questions.

Table 1. Students’ choices to the learning & trust questions. The responses fell into the following categories. Chi-square goodness of fit test was significant at p<.001 for all questions.

<table>
<thead>
<tr>
<th>Question</th>
<th>Context</th>
<th>Variable</th>
<th>Pulleys</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rental-A</td>
<td>Rental Store</td>
<td>Not specified</td>
<td>Fixed &amp; Movable</td>
</tr>
<tr>
<td>Rental-B</td>
<td>Rental Store</td>
<td>Not specified</td>
<td>Movable &amp; Double Compound</td>
</tr>
<tr>
<td>Test-A</td>
<td>Exam</td>
<td>Force</td>
<td>Fixed &amp; Movable</td>
</tr>
<tr>
<td>Test-B</td>
<td>Exam</td>
<td>Work</td>
<td>Fixed &amp; Movable</td>
</tr>
<tr>
<td>Test-C</td>
<td>Exam</td>
<td>Force</td>
<td>Movable &amp; Double Compound</td>
</tr>
<tr>
<td>Test-D</td>
<td>Exam</td>
<td>Work</td>
<td>Movable &amp; Double Compound</td>
</tr>
<tr>
<td>Make Up-A</td>
<td>Missed Lab</td>
<td>Force</td>
<td>Not specified</td>
</tr>
<tr>
<td>Make Up-B</td>
<td>Missed Lab</td>
<td>Work</td>
<td>Not specified</td>
</tr>
</tbody>
</table>

Results

Trust: Reasons for Selecting Virtual
- Students prefer hands-on activities when they think the physical or virtual manipulative will be more useful in that situation.
- Students view virtual manipulative as most useful in all contexts. Although our prior research indicates students’ learning about different topics (i.e. force and work) is better supported by different manipulatives, students responses did not follow this pattern. The activation of their epistemic resources seems to be more closely tied to the questions context.
- Comparing students’ reasoning reveals a difference in opinion about whether it is better to include or exclude frictional effects in the experiments.
- Further study could explore whether the extent to which students believe the physical or virtual manipulatives are useful mediates the time and effort they invest in their learning, thus influencing what students learn from each manipulative.

Background
- Simulations can be more affordable, safer and more accessible than physical experiments.
- Studies on student learning with physical and virtual manipulatives show mixed results (e.g. Zacharia, Olympia & Papaevripidou, 2008; Zacharia & Constantinou, 2008).
- Our research (Gire, et al. 2010) shows that different sequences of physical and virtual manipulatives do not equally support student learning.

Epistemology
- Includes and individual’s beliefs about what knowledge is, how something is known, how knowledge is evaluated, and the source of knowledge (Hofer, 2001).
- May affect how students evaluate new knowledge and choose between discrepant events, e.g. ideas developed from experimenting with different manipulatives.
- Hammer & Eby (2002) describe the form as epistemic resources which are activated in a particular context.

Research Questions
- How do students perceive learning experiences supported by physical and virtual manipulatives after engaging in each activity?
  - Which do they perceive as more useful in various contexts?
  - Which do they perceive as better supporting their learning?
  - Which do they perceive as more trustworthy?

Participants
- Students (N=134) enrolled in a conceptual-physics laboratory based on a large Midwestern U.S. university.
- Non-science majors.
- Many did not take physics in high school.
- Students may or may not be enrolled in the lecture section of the course.

Data Sources
- Survey questions that varied context (rental store, exam or missed laboratory), physical quantity (force or work) and pulley system (fixed & movable or movable & double compound) to explore whether students thought the physical or virtual manipulative would be more useful in that situation.
- Survey questions about which manipulative students trusted more and which they felt helped them learn better.