Comparing the Effects of Physical and Virtual Experimentation Sequence on Students’ Understanding of Mechanics

Adrian Carmichael, Jacqueline J. Chini, Elizabeth Gire & N. Sanjay Rebello, Kansas State University
Sadhana Punthambekar, University of Wisconsin, Madison

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OBJECTIVE
Investigate how the order of using physical and virtual manipulatives affects students’ understanding of physics concepts underlying pulleys.

ABSTRACT
This study aims to understand how the sequence of physical and virtual activities affects student conceptual understanding of pulleys. We compared pre-, mid-, and post-test scores of two treatment groups, which differed by the temporal order in which physical and virtual activities were completed. We examined overall scores as well as scores on individual questions. In questions dealing with the concept of work, students who performed the virtual experiment first seemed to have blocked information learned in the physical. In questions about force, students in each treatment group showed similar gains from pre- to mid-test but from mid- to post-test there was no gain, consistent with the primacy effect. Further, students who performed the physical experiment first did better on force mid-test questions, consistent with advantages of kinesthetic learning.

INTRODUCTION
• Previous Research: Virtual manipulatives (computer simulation) as effective as physical manipulatives (real experiment) in supporting student learning under some conditions. [1-4]
• This Research: Use both manipulatives, but change the order in which physical and virtual manipulatives are used.
• Theory: Blocking [5], Primacy Effect
  • Blocking: Learners presented with two cues in a sequence respond to the first cue over the second because the latter is either disregarded or deemed unnecessary. Blocking can be affected by the relative salience of cues.
  • Primacy: Learning dominated by first in a series of learning experiences. Familiarity, personal significance of material promotes primacy effect.

METHOD
• Context: Conceptual Physics Lab, Non-science majors.
• Curriculum: CoMPASS: Design-based, integrates concept maps & hypertext prior to physical or virtual experiments.
• Data: Pre-, mid- and post-test scores: overall & question subsets.

RESULTS

Test Scores by Concept Tested

'Effort Force' Concept
• Increase from pre- to mid-test for both PV and VP, but PV students scored higher on the mid-test.
• No change from mid- to post-test for both PV and VP.

'Work' Concept
• PV Sequence: Increase from pre- to mid-test, followed by no change from mid- to post-test, after using real pulleys.
• VP Sequence: No change from pre- to mid-test, followed by significant mid- to post-test increase, after using simulation.

DISCUSSION & CONCLUSIONS

'Effort Force' Concept
• Concept is equally salient in virtual and physical experiments, so blocking occurred equally in both sequences. Neither sequence is preferred based on saliency.
• Primacy effect observed in both sequences. Consistent with notion that familiarity induces primacy effects. 'Effort Force’ is a familiar concept to students.
• PV group scored higher than VP group on ‘Effort Force’ questions. May be due to kinesthetic learning advantages provided by physical experiment. Important for the physical experiment to occur first to prevent blocking.

'Work' Concept
• Virtual experiment provided high salience for ‘Work’ concept using a dynamically increasing bar chart.
• PV Sequence: This high salience may have blocked further learning from the physical activity.
• PV Sequence: No evidence of blocking – Consistent with blocking reduced if the second cue is more salient than first.

REFERENCES