Effects of the Order of Physical and Virtual Activities

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This work is funded in part by U.S. Department of Education, Institute of Education Sciences, Award # R305A080507

OBJECTIVE

Investigate how the order of using physical and virtual manipulatives affects students' understanding of physics concepts underlying pulleys as well as students' confidence in their understanding of these concepts.

INTRODUCTION

Previous Research: Virtual manipulatives (computer simulations) as effective as physical manipulatives (real experiments) in supporting student learning under some conditions. [1-4]

Research Questions

•How does the temporal order of using physical and virtual manipulatives affect students' conceptual understanding of pulleys?

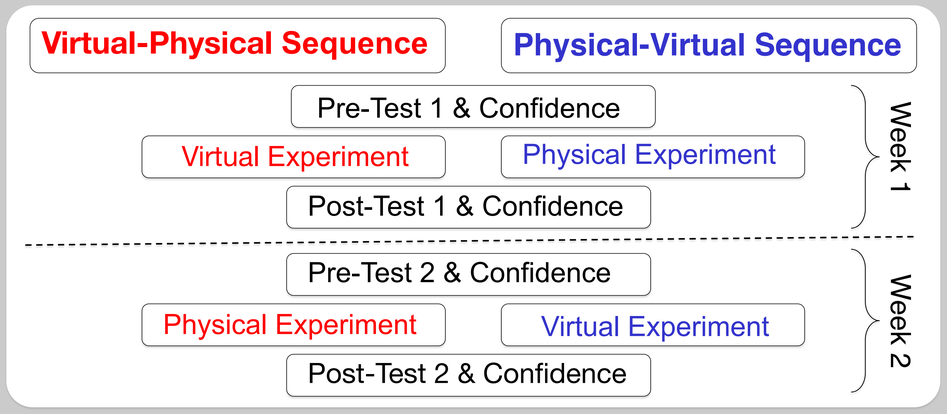
•How do students' confidence in their test answers change as they use physical and virtual manipulatives?

METHOD

Context: Conceptual physics lab, non-science majors

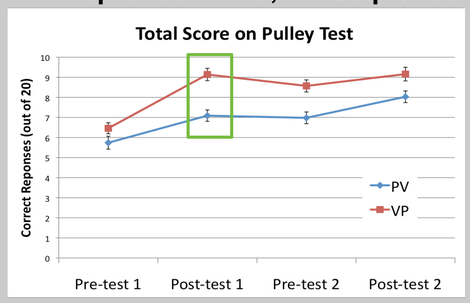
Curriculum: CoMPASS: Design-based, integrates concept maps & hypertext prior to physical or virtual experiments.

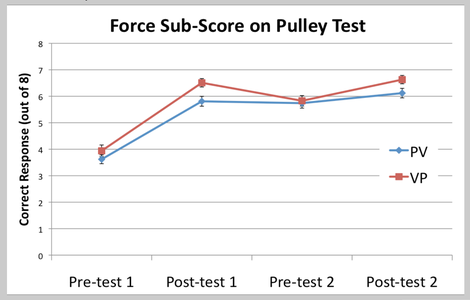
Data: Pre-test 1, post-test 1, pre-test 2 and post-test 2 scores: overall & question subsets, as well as 5-point Likert scale self-rating of confidence on each test.

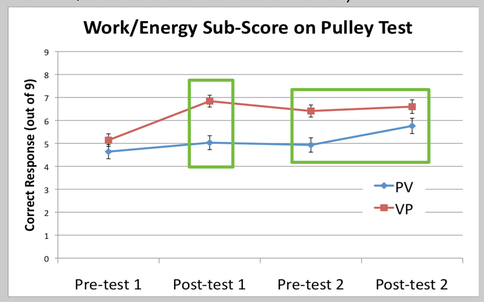


RESULTS

VP sequence: N=63, PV sequence: N=58 (*confidence data: N=42 for PV and N=47 for VP, due to data collection error)







Total Score

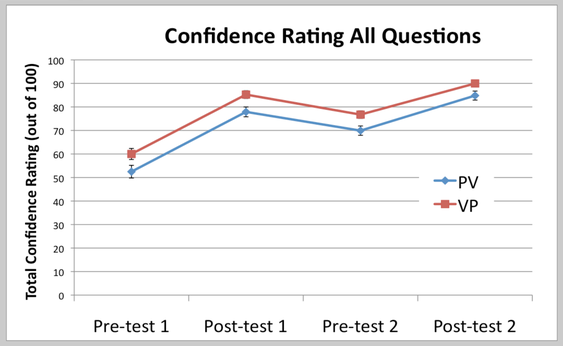
- VP students scored higher on post-test 1 (F (2.6, 223.3)=4.3, p=.008). Scores for both sequences changed similarly thereafter.
- No difference between pre-test 1 and post-test 2 based on sequence (F(1,87)=3.1, p=.082).

Force Concept

- No difference in test scores based on sequence.

Work/Energy Concept

- VP students scored significantly better on post-test 1 (F (2.6, 228.8)=5.1, p=.003).
- PV students made a steeper increase between pre-test 2 and post-test 2 (F(1,119)=6.3, p=.013).
- No difference between pre-test 1 and post-test 2 based on sequence.



Confidence Rating

- No difference in students' reported confidence based on sequence.
- Significant changes in confidence between each test.

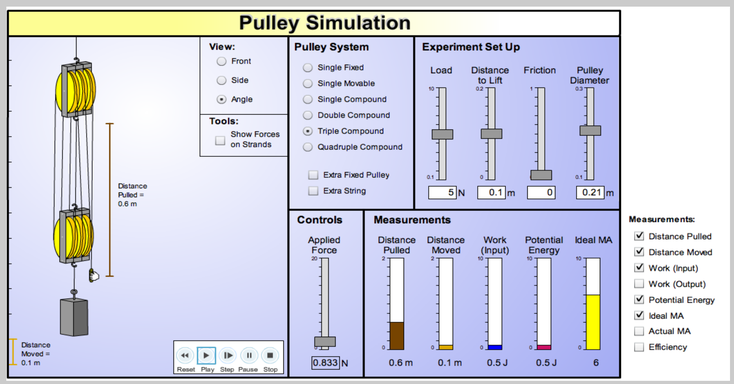
CONCLUSION

Total Score: Students who perform the virtual experiment first (VP sequence) score higher on post-test 1. There is no difference in student learning from pre-test 1 to post-test 2 based on sequence.

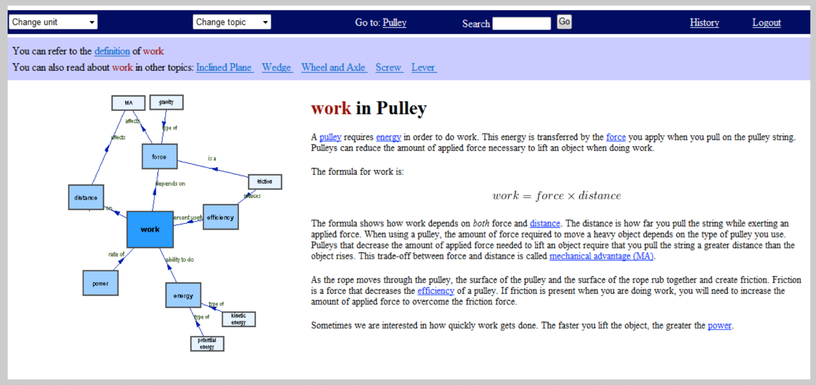
Force Concept: Students learn about force equally well in both the PV and VP sequences.

Work/Energy Concept: Students learn the most about work and energy after performing the virtual experiment, regardless of sequence. The simulation presents an idealized (frictionless) situation which graphically displays the abstract quantities of work and potential energy. These features likely help students learn more.

Confidence: Student confidence in test answers improves from pre-test 1 to post-test 1, declines from post-test 1 to pre-test 2 and improves from pre-test 2 to post-test 2. Confidence ratings changed similarly for both sequences of experiments performed.



Computer simulation used for virtual experiment. Features dynamic bar charts and clickable measurement choices.



CoMPASS (Concept Mapped Project-based Activity Scaffolding System) hypertext environment with clickable "fish eye" concept maps and textual descriptions of concepts related to simple machines.

REFERENCES

1. De Jong, T. & Van Joolingen W.R., (1998) Scientific Discovery Learning With Computer Simulations of Conceptual Domains, *Review of Educational Research*, 68, 179-201.
2. Finkelstein, N. D., Adams, W. K., Keller, C. J., Kohl, P. B., Kohl, K. K., Podolefskey, N.S., et al. (2005). When learning about the real world is better done virtually: A study of substituting simulations for laboratory equipment. *Physical Review Special Topics- Physics Education Research*, *1*, 010103.
3. Klahr, D., Triona, L. M., & Williams, C. (2007). Hands on what? The relative effectiveness of physical versus virtual materials in an engineering design project by middle school children. *Journal of Res. in Science Teaching, 44*(1), 183-203.
4. Zacharia, Z. C. & Constantinou, C. P. (2008). Comparing the influence of physical and virtual manipulatives in the context of the Physics by Inquiry curriculum: The case of undergraduate students' conceptual understanding of heat and temperature. *American Journal of Physics, 76*(4&5), 425-430.