Seventh-Grade Students' Ideas of Force and Work in Simple Machines

N. Sanjay Rebello
Kansas State University

Mary J. Leonard
Sadhana Puntambekar
University of Wisconsin, Madison

Supported in part by National Science Foundation grant DRL- 0437660 1

Research Questions

- What is the range of seventh-grade students' conceptions of effort force and work in the context of simple machines?
- How do these conceptions change over the course of a design-based curriculum on simple machines?

2

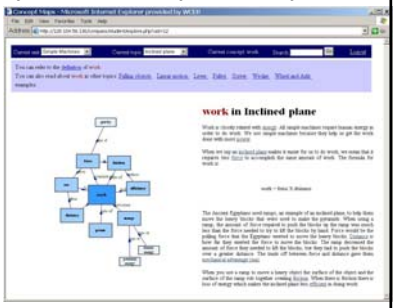
Research Context

- Seventh-grade classroom in rural Wisconsin
- 24 students in class
  - 23 Caucasian
  - 1 Pacific Islander
- 8-week curriculum on Simple Machines
  - Inclined plane
  - Wedge & Screw
  - Lever
  - Wheel & Axle
  - Pulley

3

CoMPASS Curriculum

- Concept Mapped Project-based Activity Scaffold System
- Integrates
  - Hypertext
  - Concept maps
  - Hands-on
  - Design challenges
  - Inquiry cycles



4

Data Sources

- Pre-Post Conceptual Test (N=19)
  - Effort force,
  - Work,
  - Force-distance tradeoff, and
  - Mechanical advantage in simple machines
- Structured Interviews (N=10)
  - I: After 2 weeks : After inclined plane
  - II: After 5 weeks : After wedge, screw, lever, wheel & axle
  - III: After 8 weeks : After pulley – end of curriculum

5

Results: Conceptual Tests

	N	Mean	S.D.
Pre-Test	19	12.32 / 20	3.07
Post-Test	19	17.63 / 20	4.35

Paired Sample T-test				
Difference in Means	t	df	p (t<T)	Effect Size
5.316	5.096	18	~$1x10^{-4}$	1.17

6

Results: Interviews (slide 1 of 2)

FREQUENCY OF IDEA	Interview			ALL
Effort Force is...	I	II	III	
a measurable quantity	9	6	5	20
a push, pull, or lift	9	5	6	20
associated with a person	6	5	6	17
an input to something	1	4	3	8
what it takes to do something	5	1	1	7
associated with motion	3	2	2	7
overcome difficulty of motion	1	1	2	4
work / power	1	3	0	4
load, weight being lifted	0	1	2	3

Results: Interviews (slide 2 of 2)

FREQUENCY OF IDEA	Interview			ALL
Work is...	I	II	III	
associated with a person	7	4	7	18
labor to do a task	4	4	2	11
effort / force	4	3	1	9
a push, pull or lift	3	2	2	7
an input into something	1	4	3	8
associated with motion	1	4	3	8
a measurable quantity	1	1	5	7
related to force & distance	0	1	1	2
energy	0	1	0	1

Conclusions

- Ideas of Effort Force & Work
  - Measurable quantities : effort force more so than work
  - Person-centered : about equally for effort force and work
  - Effort Force and Work used interchangeably
- General trend toward science conceptions, but...
  - Trend *away from* Effort Force as quantity or push / pull
  - Trend *toward* Work as quantity, associated with motion
  - Trend *away from* Work as equivalent to Effort Force

9

Implications for Curricula

- Experiencing phenomena directly (measurement rather than calculation) appears to support science conceptions.
- Attention to scientific language and relationship to everyday language is critical.
- Context of activity can strongly influence conceptions of scientific phenomena.

10

Further Information?

N. Sanjay Rebello
(srebello@phys.ksu.edu)

Physics Education Research Group
Kansas State University

11