

# Students' Conceptions About Rolling In Multiple Contexts

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## INTRODUCTION

- Research by Rimoldini & Singh (2005) found that students
  - are unable to compare velocities at top and bottom of rolling wheel.
  - are unable to shift reference frame from point at center of wheel to fixed point on earth.
  - do not understand what 'rolling without slipping' means.
- However, prior research has ...
  - primarily explored one context : single rolling wheel.
  - not investigated resources that that students use to describe rolling.

## FRAMEWORK

Resources (Hammer, 2000) : chunks of knowledge that students use in a given context.

## RESEARCH QUESTION

What resources do students use to reason about rolling in different contexts?

## DATA SOURCES

- Phase I : Calculus-based physics, public university
  - Context 1 ('Single Wheel') : Homework (N ~ 100)
  - Context 2 ('Plank on Drum') : Exam (N ~ 100)
  - Context 3 ('Penny Farthing') : Interview (N = 13)
- Phase II : Algebra-based physics, different university
  - All three contexts on a single survey (N ~ 200)

## DATA ANALYSIS

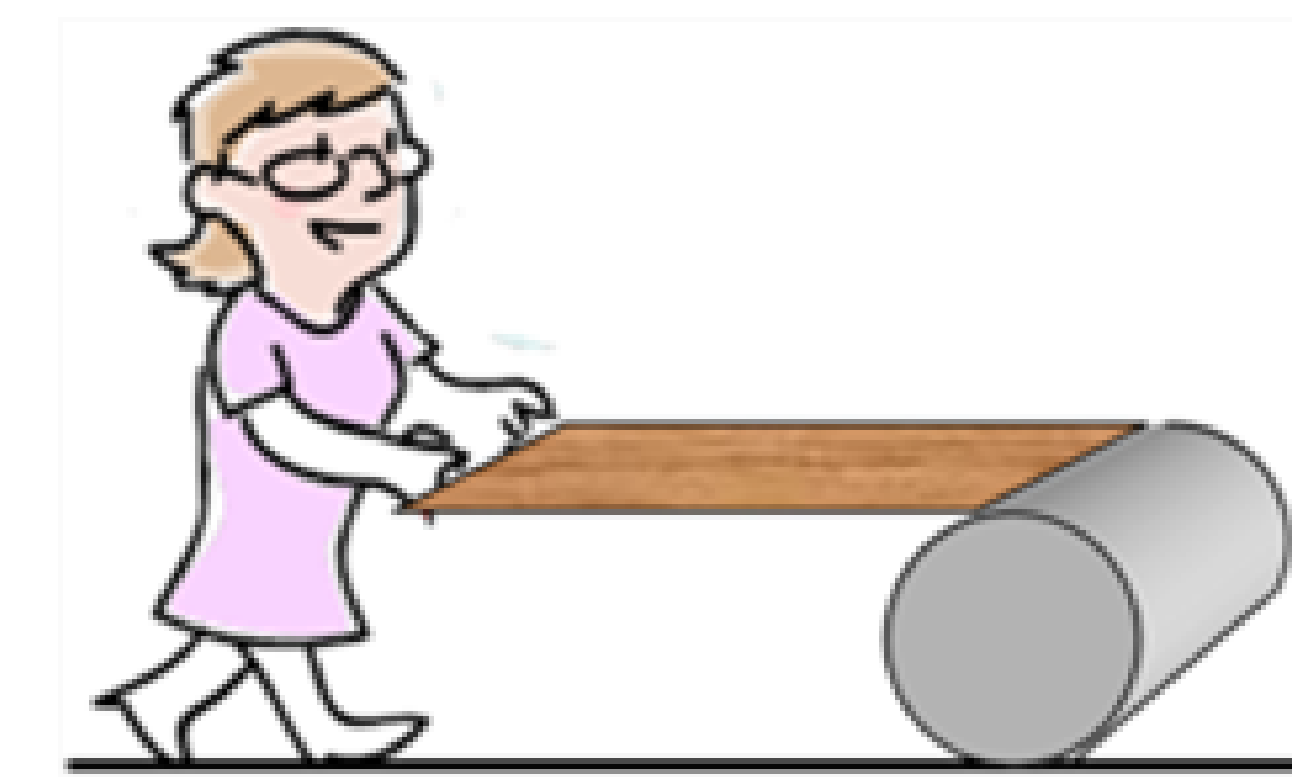
Phenomenographic analysis (Marton, 1986) :  
Coded written/oral responses → Categories  
→ Emergent Themes

### 'Single Wheel'

You and your friend are on a bike ride. On a flat section of the road you chat about the speeds of points on the bicycle wheel with respect to the road. Your friend asks, "At any instant, how does the linear velocity with respect to the ground of the point at the top of the wheel compare with the linear velocity with respect to the ground of the point at the bottom of the wheel?" What is your answer? Explain your reasoning.

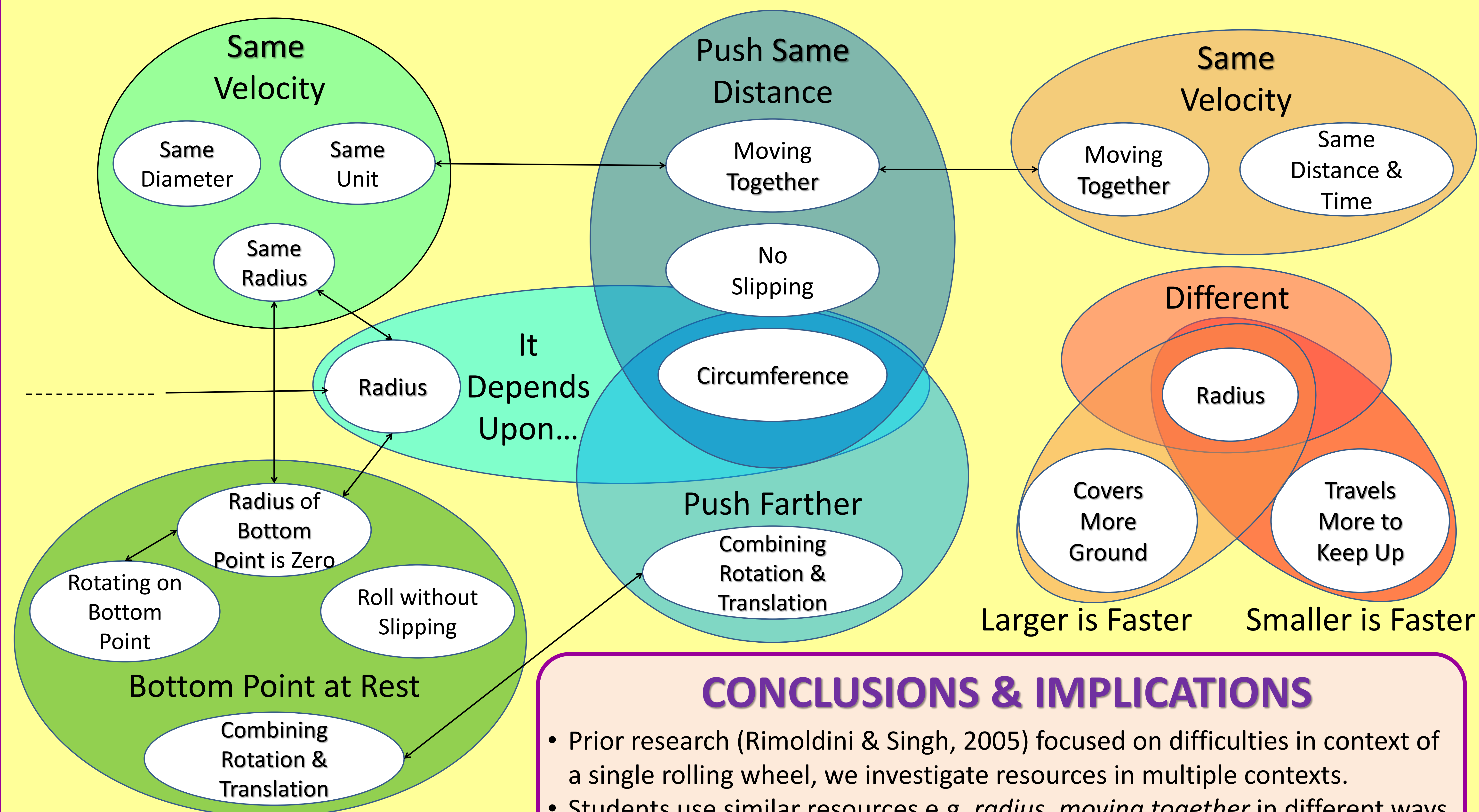
### 'Plank on Drum'

You take your kid sister for a walk through the park. For fun, she takes a plank, places it on top of a drum and pushes the plank so that the drum rolls forward. The plank moves along the top edge of the drum without slipping. She asks, "If I want to move the drum two feet forward, how many feet forward would I have to push the plank?" What is your answer? Explain your reasoning.



### 'Penny Farthing'

You and your friend see a person riding down the street on a penny-farthing bicycle shown. Your friend asks, "At any instant, how does the linear velocity of the point at the top of the front wheel compare with the linear velocity of the top point of the rear wheel?" What is your answer? Explain your reasoning



## CONCLUSIONS & IMPLICATIONS

- Prior research (Rimoldini & Singh, 2005) focused on difficulties in context of a single rolling wheel, we investigate resources in multiple contexts.
- Students use similar resources e.g. *radius*, *moving together* in different ways across problems.
- Instruction must facilitate students to refine these existing resources to construct their reasoning.