Dynamics of Students' Modeling of Microscopic Friction*

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Research Questions

- What associations do students construct between information provided through external inputs and their own internal knowledge?
- What factors mediate these associations and how do these associations influence the students' model construction/reconstruction of microscopic friction?

Theoretical Framework

Contemporary Perspectives of Transfer

- Actor-oriented transfer[1]
  - personal creation of similarities
- Preparation for future learning[2]
  - adaptability to new situations
- Coordination class theory[3]
  - Class C transfer (re-use prior knowledge)

[1]Lobato (2003) [2]Bransford & Schwartz (1999) [3]diSessa & Wagner (2005)

Methodology

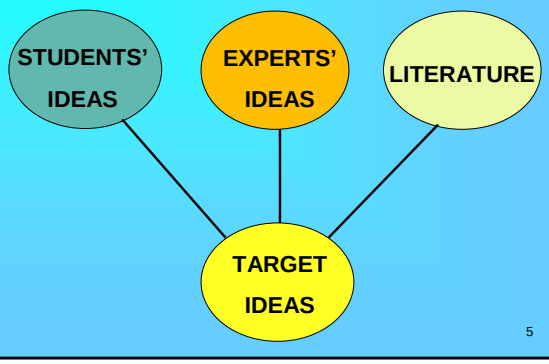
Teaching Interview[4]

- 'Mock' instruction
- Two one-hour session/student
- Videotaped

Phenomenographic Approach[5]

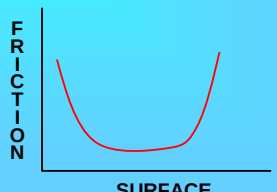
[4]Engelhardt *et.al* (2003) [5]Marton (1986)

Establishing Target Ideas



Target Ideas
(Relevant to this Talk)

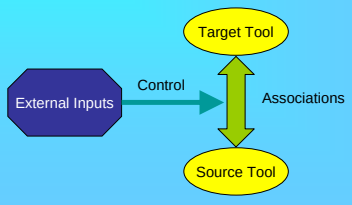
- Friction is dependent on the real area of contact.
- Friction varies with roughness as shown below:



Analytical Framework

'Two-level framework'

- Associations between knowledge elements.
- Control of these associations.



Redish (2004)

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The Informant

- Introductory College Physics Student
  - Had High School Physics
  - Enrolled in second semester calculus-based physics.

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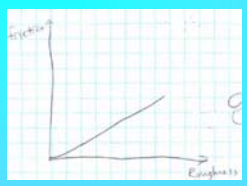
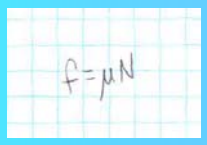
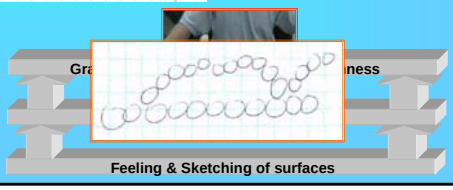
Model Building







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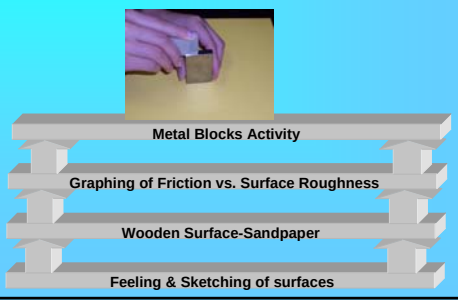
Model Building



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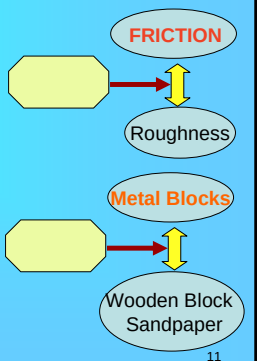
Metal Blocks Activity-Prediction

Slide 1 of 2

…. The top (smooth) and the (rough) sides will probably have more friction because they are not both quite smooth. The top will be less because they are both quite smooth.

<..basis of prediction?> …just the roughness and smoothness of the sides. The more roughness there is, there'll be more friction. Basically it's the same reasoning I used for these (points to the wooden block and sandpaper)



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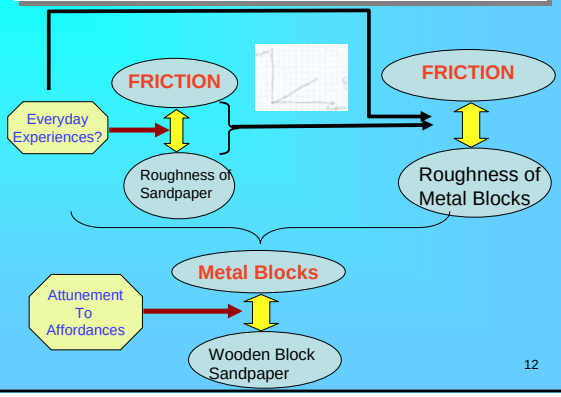
Metal Blocks Activity-Prediction

Slide 2 of 2



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Metal Blocks Activity-Explanation

??COGNITIVE DISSONANCE??
Can't explain phenomena at hand using present model

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Model Building

Papers & Transparency

Metal Blocks Activity

Graphing of Friction vs. Surface Roughness

Wooden Surface-Sandpaper

Feeling & Sketching of surfaces

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Paper & Transparency - Prediction

"…greater friction would probably be that one (uncrumpled paper) because it's gonna have more area in contact with the surface because it's flat…"

Intuition? → FRICTION ↕ Contact Area

"…but actually wait, they would be the same because I guess friction doesn't really depend on the surface area touching the surface…"

From Class → FRICTION ✕ Contact Area

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Paper & Transparency - Explanation

"…because in that one (uncrumpled) the entire surface is resting on top of the plastic. In here (crumpled paper) it has very few points of contact and so it's not attracted as much as that one (uncrumpled)."

From Activity → Force to Pull ↕ Contact Points

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Model Reconstruction

Revisit Graph

Questions, Other Hints & Cues by Interviewer- Researcher

Sketching of Pair of Surfaces

Papers & Transparency

Metal Blocks Activity

Graphing of Friction vs. Surface Roughness

Wooden Surface-Sandpaper

Feeling & Sketching of surfaces

Questions, Other Hints & Cues by Interviewer- Researcher

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Model Reconstruction In Progress

"…with the smoother it is, like here (smooth side of the metal block), there's a lot more friction and as it gets a little bit rougher like the sides (rougher side of metal block) there'll be less friction."

Metal Blocks & Paper-Transparency Activity → Friction ↕ Increasing Smoothness

…once you get really, really rough like the sandpaper, it will start to go up again, so there'll be more friction."

Wooden Block-Sandpaper Activity → Friction ↕ Increasing Roughness

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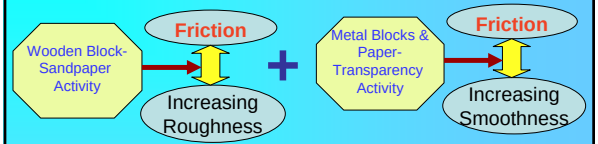
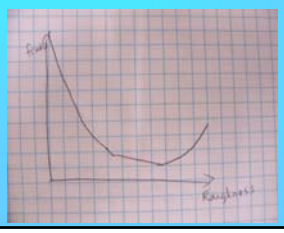
Model Reconstruction In Progress





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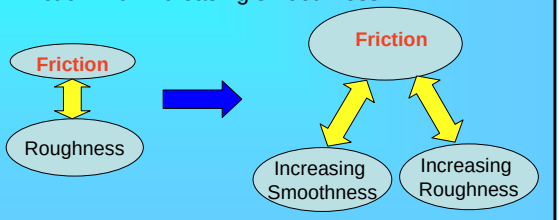
Conclusion

Slide 1 of 2

- The metal block and transparency activity seem to activate and strengthen the association of friction with increasing smoothness.



BEFORE **AFTER**

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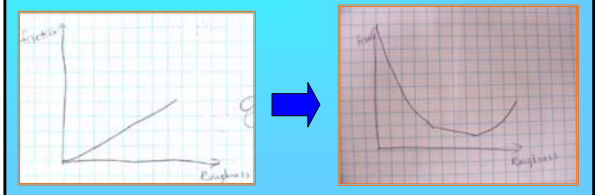
Conclusion

Slide 2 of 2

- The scaffolding activities appeared to facilitate efficient control of the activation of appropriate associations to explain his observations and construct a new model of microscopic friction.



BEFORE **AFTER**

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Current Directions

- Develop Instructional Material
- Validate & Pilot Test Instructional Material

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Thank You!!!

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