DYNAMIC TRANSFER IN THE CONTEXT OF MICROSCOPIC FRICTION: CASE STUDY WITH AN INTRODUCTORY COLLEGE STUDENT*

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Abstract

We conducted teaching interviews with an introductory college physics student to investigate the dynamics of his/her model (re)construction of an unfamiliar phenomenon - microscopic friction. Various scaffolding activities, hints, clues and other prompts were provided during the teaching interview to help him/her construct a progressively more scientific model of microscopic friction. Our data were analyzed using a framework that is consistent with the contemporary notions of transfer. We present a detailed analysis of the model (re)construction processes including association building and control.

Research Questions

- What associations does a student construct between information provided through the external inputs and her/his own internal knowledge?
- What factors mediate these associations and how do these associations influence the student's 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]

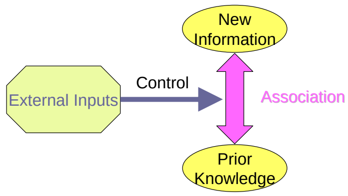
[4]Engelhardt *et al.* (2003) [5]Marton (1986)

The Informant

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

Analytical Framework

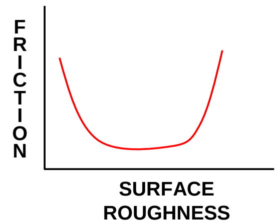
- 'Two-level framework'[6]
  - Associations between knowledge elements.
  - Control of these associations.



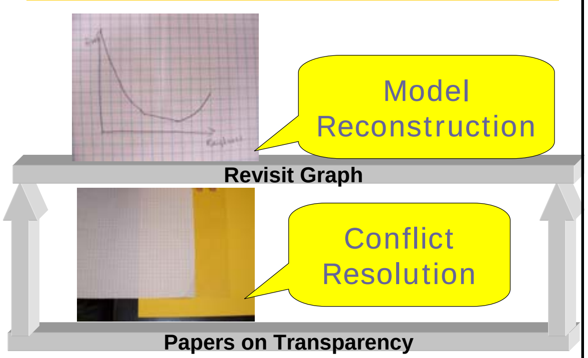
[6] Redish (2004)

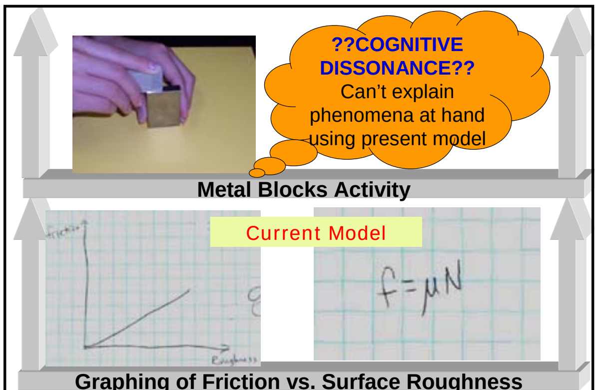
Target Ideas

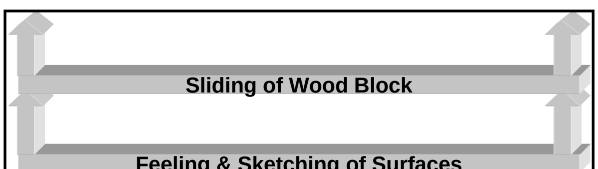
- Friction is dependent on the real area of contact.
- Friction varies with roughness as shown below:



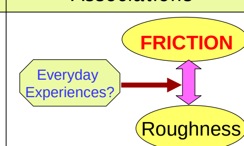
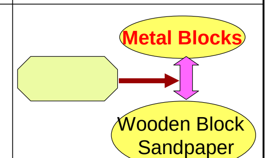
Scaffolding Activities



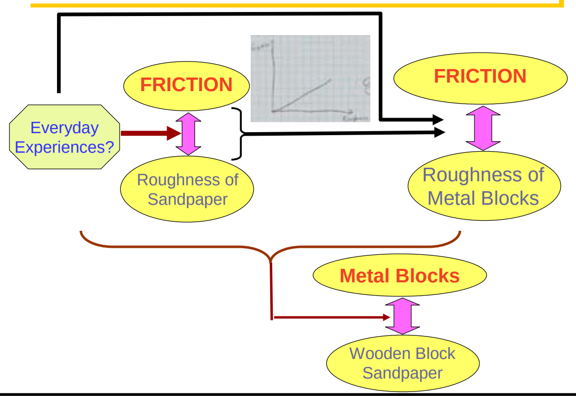




Metal Blocks Activity-Prediction

Transcript	Associations
…. 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 the wood block on the sandpaper.	

Associations & Controlling Factors



Paper on Transparency-Prediction

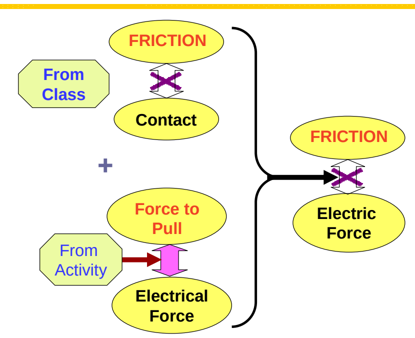
Transcript	Associations
"…greater friction would probably be on the uncrumpled paper because it's gonna have more area in contact with the surface because it's flat…"	Intuition? → Friction ↕ Contact Area
"…but actually wait, they would be the same because I guess friction doesn't really depend on the surface area touching the surface…"	From Class → Friction ✕ Contact Area

"…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

Explanation of Observation

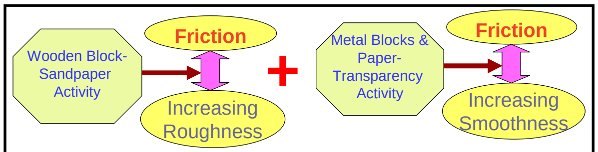
Transcript	Associations
This one (uncrumpled paper) is a lot harder to pull but it's probably because of some electrostatic attraction between the plastic and the paper. So I guess that's really not friction.	From Activity → Force to Pull ↕ Electrical Interaction; From Class → Force to Pull ✕ Friction
...there was less points of contact... because in that one (uncrumpled) the entire surface is resting on the plastic. In here (crumpled paper) it has very few points of contact and so it's not attracted as much…	From Activity → Force to Pull ↕ Contact Points

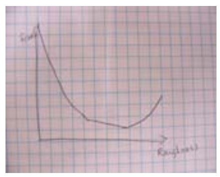
Construction of New Associations



Model Reconstruction In Progress

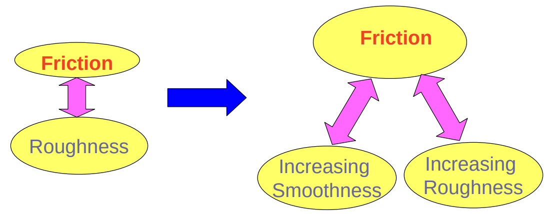
Transcript	Associations
"…with the smoother it is, like here (smooth metal block side), there's a lot more friction…as it gets a little bit rougher like the sides (rougher side of metal block) there'll be less friction."	Metal Blocks & Paper-Transparency Activity → Friction ↕ Increasing Smoothness
…once you get really, really rough like the sandpaper, it will start to go up again, so there'll be more friction."	Wood Block-Sandpaper Activity → Friction ↕ Increasing Roughness





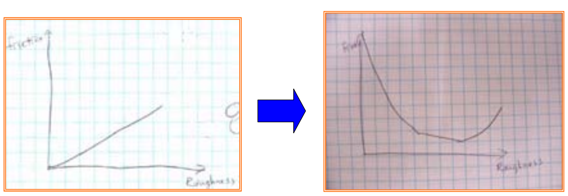
Conclusion

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



BEFORE **AFTER**

- 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**