Our Model of Transfer & Applications to Our Research

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Our Research Theme:
Student Thinking of Real-World Contexts

Why study real-world contexts?
Real-world contexts ...
- motivate students to learn physics.
- promote inductive reasoning – principles developed from observations.
- provide situations for design-based problem solving.


Our Research Questions

- How do students construct and transfer knowledge when thinking about real-world contexts?
- What factors mediate these processes?

Which Real-World Contexts?

Contexts chosen based on following criteria...
- Have all students experienced it in some way?
- Is it amenable to hands-on exploration?
- Are underlying principles in clear view?
- Are principles transferable to other contexts?

In spite of these criteria...
Most students have ...
- Seldom given prior thought to how real-world devices work, although they have used them.
- Do not have well formed ideas about the working of these devices.
- Make up their thoughts on the spot, when asked how the devices work.
Example: Interview on Optic Fibers  

From what I understand, it’s a, it’s almost a series of reflections. … I’m pretty sure it’s reflected light all the way through. …

I think just by a series of angled, um, I don’t want to say mirrors, but it’s got to be mirror-like, a mirror-like substance. … I guess if, if you did just enclose light in, … uh, it can’t be glass ‘cause it’s flexible. … I don’t know how you would do it. …

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Implications for Physics Education Research

- Stability of knowledge is questionable.
- Framework: p-prim4/resource5 rather than coherent mental model.
- Difficult to probe student knowledge without affecting it.
- Focus on dynamics of knowledge transfer & construction rather than state of knowledge.

'Strategic' Views of Transfer

- Identical elements must exist between contexts.
- Knowledge must be encoded in a coherent schema.
- Researcher pre-decides what must transfer.
- Static one-shot assessment.
- Focus mainly on students' internal knowledge.
- Transfer is rare.

What is Transfer?

Ability to use what you have learned in one situation in a different situation.

However, in light of earlier discussion...

Do we need to rethink what transfer actually means?

E.g. McKeough, Lupart & Marini (1995)

'Traditional' Views of Transfer

- (Re)construct knowledge in new context.
- Knowledge transfers in pieces.
- Researcher examines anything that transfers.
- Dynamic, real-time assessment.
- Focus also on variety of mediating factors.
- Transfer is ubiquitous.

E.g. Gick & Holyoak (1980); Reed & Ernst (1974), Thordike (1906)


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What Affects Transfer?
- The Mediating Factors

- **Expectations** about new situation.
  - e.g. “Knowledge of mathematics expected in this class.”

- **Epistemology**: Beliefs about nature of knowledge.
  - e.g. propagated (from authority) vs. fabricated (by oneself).

- **Motivation** to apply knowledge.

- **Social interactions**.

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Dynamic Transfer

Our Interview Data
(5 different projects & researchers)

Our Model of Dynamic Transfer

Other Contemporary Views

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Underpinnings of Model

- ‘Two-level framework’
  - **Associations** between knowledge elements.
  - **Control** of these associations.

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Elements of Model

Tools

- **Source Tool**: Dormant knowledge activated to make sense of a situation.
- **Target Tool**: Attributes of a situation that a learner ‘read out’ from the external inputs provided.
- **Epistemic Meta-Tool**: Epistemic Resources that a learner uses to exercise executive control over process in working memory.

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Processes

- **Read-Out**: Recognizing relevant information in from the external input.
- **Activation**: Retrieval of source tools or epistemic meta-tools from long term memory.
- **Association**: Interconnecting various tools in the working memory e.g. inferential, causal, analogical inductive, deductive.
Using the Model

Examining interview data based on the model

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Knowledge is Created

Target Tool:
What she notices

Source Tool:
Not glass b/c flexible

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Also...

Our model can be used to describe the concept construction process.
Through successive activation/deactivation of associations between tools, a complex knowledge structure may be constructed and stored in long term memory. Structure (of tightly associated tools) may be activated in future as a single entity (model).

Eventually...

- Through successive activation/deactivation of associations between tools...
- ...a complex knowledge structure may be constructed and stored in long term memory.
- Structure (of tightly associated tools) may be activated in future as a single entity (model).

Conceptual Change Processes

- Assimilation: New 'tool' adds to existing structure without fundamentally changing it.
- Accommodation: New 'tool' changes existing structure.

Our Model of Transfer

- Transfer is the dynamic creation of associations between knowledge elements ('tools').
- Associations are controlled by the learners' epistemic mode.
- Epistemic mode is activated by external inputs.
**Commonalities with Other Models**

1. **Mestre, Dufresne et. al.**
   - Dynamic process leading to activation and application of knowledge in response to context.
   - ‘Read-out’ filter: Noticing relevant info. in situation.
   - ‘Expectation filter: Activating and applying knowledge pieces to make inferences.

2. **Hammer, Redish, Elby et. al.**
   - Locally coherent, mutually associated resources activated together based on learner’s epistemic frame.
   - Transfer occurs when learner reaches similar state in new context.

**Schwartz, Bransford et. al.**
- Transfer is prep for future learning.
- ‘Transfer In’: during knowledge construction.
- ‘Interpretive’ (knowing with): Framing the situation.

**disSessa & Wagner**
- ‘Class A’ Transfer: Developed knowledge (co-ord. class).
- ‘Class C’ Transfer: Small-grained knowledge activation.
- ‘Class B’ Transfer: Transition between Class A and C.

**Applications to Our Research**

- What target tools do they read out?
- What source tools do they activate?
- What assoc. do they construct b/w these?
- In what epistemic state do they frame the situation?
- What external inputs prime them into this state?

**Example from ‘Movie Physics’**

- Movie clip: ‘Speed’
- Question / Hint
- Demo with toys
- Explain using physics terms.
- Explain in own words, what I figure
- Projectile motion: no vertical speed.
- Never seen this happen

**Example from ‘Friction’ study**

- Question / Hint
- Gauge block activity
- Talk w/ other student
- Use what I learned in class. Try to figure out from activity.
- Notice harder to move on smoother surface.
- No ‘tool’ from class to relate to?
- Relate to transparency on paper.

**Applications to Our Research**

- What questions to ask?
  - How to phrase questions to activate desired e-mode?
- What knowledge building experiences to provide?
  - What hands on activities, demos to use?
  - How to generate cognitive dissonance?
- How to analyze data?
  - What students actions and interactions to focus on?
  - What coding rubric to use?
Implications for Curriculum Design

Typical Methodology

- Determine students’ prior knowledge
- Design interventions to change knowledge

Clinical Interviews → Curriculum Design & Development → Pilot- & Field-Testing

Alternative Methodology

- Explore external inputs that activate productive epistemic modes and useful tools and processes leading to knowledge construction
- Determine ‘tools’ that students intuitively use & what activates these tools

Teaching Interviews → Curriculum Design & Development → Pilot- & Field-Testing

* Steffe (1983); Steffe & Thompson (2000)

What is a Teaching Interview?

- ‘Mock’ instruction:
  - Attempts to change student knowledge.
  - Rich setting for students to express themselves.
  - Variety of instructional strategies.
  - Involve groups of up to three students.

- Researcher’s Role:
  - Observer.
  - Instructor.

What is a Teaching Interview?

Benefits of Teaching Interviews

- ‘Mock’ instruction:
  - Attempts to change student knowledge.
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Provide insights about ...

- Dynamics of knowledge construction & transfer.
- Effectiveness of materials & strategies.
- Student interactions with...
  - instructional materials,
  - peers, and
  - instructor.

Teaching Interviews are a useful paradigm for research and curriculum development.

SUMMARY

- Perspectives of Transfer:
  - Dynamic.
  - Student-centered.

- Our model of Transfer:
  - Consistent with new perspectives.
  - Identify & characterize dynamic transfer.
  - Can guide curriculum dev. & instruction