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### Abstract

Our theoretical framework purports two transfer mechanisms, both cognitively supported by the dynamic creation of associations between new information read-out by a learner and her internal knowledge. In 'horizontal' transfer new information is mapped onto a pre-created schema activated from the learner's long term memory. In 'vertical' transfer the new information results in the learner modifying an existing schema or constructing a new schema to make sense of the situation. Our framework suggests that to develop adaptive expertise, we must scaffold learners within their zone of proximal development as they engage in sequences of horizontal and vertical transfer tasks (V-H sequences) to navigate their optimal adaptability corridor. Based on this framework, we designed an instructional unit to facilitate transfer of problem solving strategies in physics problems requiring mathematical integration. Our results seem to suggest that the V-H sequences based on our framework are more effective in promoting transfer than traditional instruction.

# **Perspectives on Transfer**

### Early

- Identical elements must exist between situations.
- Knowledge must be encoded in a schema.
- Researchers pre-decide what must transfer.
- Static one-shot assessments e.g. tests.
- Focus on learners' knowledge & cognition.



## Emerging

- (Re)construct knowledge in new context.
- Knowledge can transfer in pieces.
- We must examine anything that transfers.
- Dynamic, real-time assessments.
- Focus also on mediating factors e.g. motivation.



# **An Instructional Framework for Developing Adaptive Expertise** through Sequencing Horizontal and Vertical Transfer Tasks

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### Framework



# **Applying the Framework**

### Goal

Test whether interventions based on V-H sequences help students transfer their problem solving skills more effectively than traditional instruction.

### Context

# Traditional Instruction

- Start with non-uniform large system & slice it up into slices of thickness  $\Delta x$ .
- Find property of the thin slice of thickness  $\Delta x$ .
- Integrate over all slices within limits of object.



- for learning.





• Calculus-based physics class for future engineers. • Problems requiring mathematical integration.

### **V-H Transfer** Sequences

- Start with individual object, find its property.
- Add up a series of N individual objects of certain thickness  $\Delta x$ .
- Take limit of  $N \rightarrow \infty$  and  $\Delta x \rightarrow 0.$

### Summary

• Both horizontal and vertical transfer mechanisms are important

• Instructional framework that incorporates sequences of small steps of both horizontal and vertical transfer can facilitate advancement toward adaptive expertise.

• Evidence that instruction designed based on the framework can facilitate transfer of problem solving skills.