

A Model for Dynamic Transfer of Learning

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Abstract

Transfer of learning is often [1] defined as applying what one has learned in one situation to a different situation. Most of the research on transfer of learning has focused on whether students who had learned a problem solving strategy in a given context were able to apply this strategy to other contexts [2] by recognizing applying a. However, the results of these and other similar transfer studies demonstrate that transfer, when measured this way is rather rare. However, almost all of us know from everyday experience that we seldom invent a procedure or strategy each time it to a new situation, rather we automatically transfer what we have learned in one situation to another. To reconcile the apparent contradiction some researchers have reconsidered the ways to characterize transfer [3-6]. In this paper we discuss our model of transfer that is based on these contemporary perspectives and has its underpinnings in cognitive psychology. We describe how our model can help characterize in vivo transfer as it occurs in an interview and its implications for research and instruction

The Building Blocks

Interviews are a useful tool to gauge the dynamics of transfer of learning and provide insights into how students apply and reconstruct knowledge and experiences gained elsewhere as they respond to a question. An interviewer may attend to a particular aspect of a student's response, at the expense of others or may unwittingly cue the student. The assumption that student knowledge remains static while it is probed in an interview ignores the dynamic in situ transfer and construction of knowledge by students.

We propose a model to characterize students' transfer in an interview. Our model utilizes the overarching structure of a two-level framework proposed by Redish [7] which in turn is based on fundamental neuro-cognitive theories. The lower level includes associations between knowledge elements, which are "relations of similarity" in Lobato's [5,6] Actor-Oriented Model. The upper level includes executive control that enhances (turns on) or suppresses (turns off) the associations between these knowledge elements based on a learner's epistemologies and expectations. Various elements of our model are described below.

External Inputs answer the question: "What prompts transfer?" An external input is information provided by the interviewer. It also includes other materials, e.g. text, pictures, demos, videos, etc. used in the interview. External inputs can play a key role in influencing transfer of knowledge. They can prime the student to focus on certain aspects of a problem situation at the expense of others. They may provide verbal and non-verbal feedback that prompts the student to think in a particular way, thereby facilitating either positive or negative transfer. Taking into consideration the external input is consistent with Greeno et al. [4] and Lobato [5,6] view that "transfer is distributed across mental, material, social and cultural planes." Interaction with the interviewer is an example of this social interaction which may cue students to access various knowledge elements or tools in their reasoning.

Tools answer the question: "What transfers?" In our model almost any object or idea, concrete or abstract, real or imaginary, can be a tool. We categorize tools in the following ways for our discussion of transfer.

'Source' Tools are pre-existing knowledge or experiences from a prior context such as real-life experience, classroom instruction, popular media or even previous interview questions [8]. Source tools include a learner's dormant knowledge that is activated to make sense of new situations.

'Target' Tools are attributes of the 'target' situation that the learner uses to "know with" [3,9]. They define the target context in the learner's mind. Target tools are presented via external inputs however not all inputs are tools. Rather the learner 'read-outs' information that she considers relevant [10] and uses this read out information as tools. Target tools may include surface features, deep structure, affordances or states of affairs [4] that a learner attends to.

'Epistemic meta-Tools' are epistemic resources ("knowledge is propagated" or "knowledge is fabricated") that a student activates to exercise executive control over workbench processes. Unlike the target tool, the epistemic meta-tool may be activated from a learner's long term memory through priming by the external input. Hammer and Elby [11] describe two kinds of personal epistemological modes – "knowledge as propagated stuff" and "knowledge as fabricated stuff." A student's personal epistemic resources affect the types of cognitive tools they use. Thus epistemic resources are "meta-tools" or higher-level tools that control the use of lower-level (cognitive) tools that the student uses.

Workbench answers the question: "How does transfer occur?" The workbench includes mental processes that utilize inputs and tools, such as making connections between various tools. Workbench processes include reorganization and restructuring of knowledge such as assimilation and accommodation [12], conceptual combination [13] or hybridization [14], analogical, inductive or deductive reasoning, and making decisions about the tools to activate in a given situation i.e. "epistemic gaming" [15] which Redish [7] describes as a "coherent activity that uses ...knowledge and ... processes to create [new] knowledge." The notion of a workbench is consistent with the idea that transfer is a dynamic process in which relations and similarities are constructed anew in the transfer context and not merely transported from the learning context. Lobato's Actor-Oriented Model [6] asks, "What relations of similarity are created? How are they supported by the environment?" The model of transfer by Greeno et al hypothesizes that "a symbolic representation of structure is generated in the transfer situation based partly on information about another situation that is retrieved." Both of these are workbench processes that allude to dynamic learning, consistent with Bransford and Schwartz's, view transfer as preparation for future learning. The following types of workbench processes are relevant to our discussion of transfer.

'Read-out' is the process by which a learner recognizes the relevance of certain attributes or transfer tools in the external inputs. A learner may be primed to notice some information at the expense of others, based on the epistemic meta-tools that are activated at that time.

'Activation' is the process by which a learner recalls into working memory, source tools or epistemic meta-tools that are dormant in long term memory.

'Association' is the process by which a learner interconnects tools in the working memory. Various types of associations are possible, e.g. inferential, causal, analogical, deductive or inductive. It is often difficult to distinguish between activation of a tool and its association with other tools. Typically when students explicate the associations that they construct, the activation is implied.

'Priming' is a higher order (meta) process by which covert meta-messages influence the way in which a learner frames the situation and activates certain epistemic meta-tools. Evidence of priming is indirectly inferred from the sources of knowledge that the learner refers to in her reasoning.

'Control' is a higher order (meta) process by which a learner enhances or suppresses associations, activations and read-out based on the epistemic meta-tools. 'Epistemic gaming' [7] by which a learner decides the types of knowledge is a controlling process. Like priming,

evidence of executive control is must be inferred indirectly from a learner’s statements (e.g. “I made it up”)

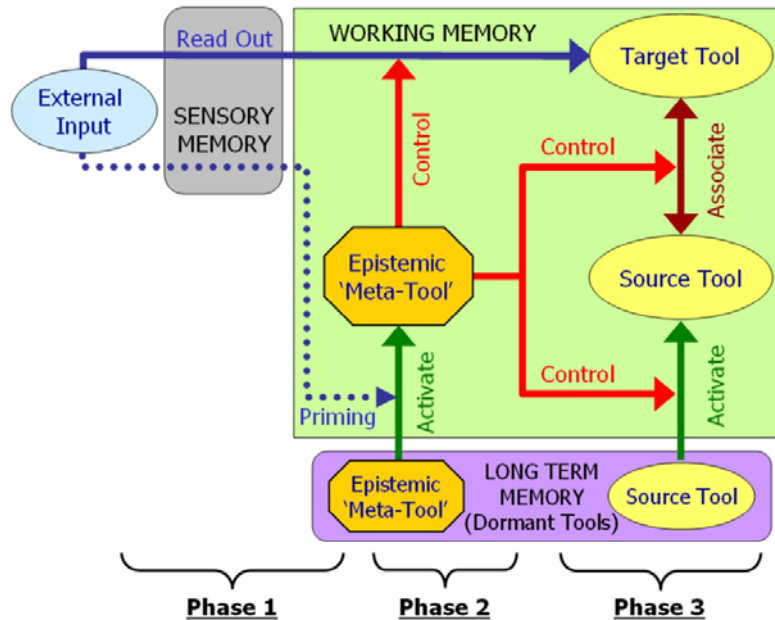


Fig. 1. *Our model of transfer*

The Mechanism

Figure 1 demonstrates our model of transfer that builds on the generic structure provided by Redish [7]. We model the transfer mechanism in three phases that are often indistinguishable.

Phase 1: The interviewer provides external input describing the problem scenario. Additionally, the interviewer also primes the learner through ‘covert messages’ to activate epistemic meta-tools

Phase 2: The activated epistemic meta-tool controls the process by which the learner weighs the relevance and reads-out certain pieces of input information to be used as a target tool in the reasoning process.

Phase 3: The epistemic meta-tool activates source tools from long-term memory. If the ‘knowledge is propagated stuff’ epistemic meta-tool is activated in phase 2, the learner is more likely to utilize knowledge acquired through formal instruction. If the ‘knowledge as fabricated stuff’ epistemic meta-tool is activated in the learner is more likely to use self-constructed knowledge. The learner establishes associations or relationships between the source and target tools. The association process described here is typically explicated by the student, while the activation process is implicit.

Therefore, in our model, transfer is a dynamic creation of associations between target tools read out from the external inputs and source tools activated from long term memory. Readout, activation and associations are mediated through higher-order control by epistemic meta-tools which are in turn activated through priming by covert meta-messages in the external input.

We acknowledge that our model of transfer includes the role of the working memory in ways that may not be consistent with existing knowledge about the limitations of working memory. One such limitation is the maximum number of items that we can attend to simultaneously in our working memory. Another limitation pertains to the maximum duration for which one can hold information in the working memory without continuous rehearsal. Our

model is silent about these limitations, because we use the term ‘working memory’ rather loosely. Further research may be needed to refine this model to be more consistent with existing notions of the working memory as used in cognitive science.

Phase 4 (not in Figure 1): Two possibilities exist. First, in the short term, the source-target tool association prompts metacognitive reflection and self-regulation [16] causing the learner to rethink the problem. Second, if the source-target tool association is strongly established to yield a new tool (comprising the two interlinked tools), that is committed to long term memory. This new tool may in future be activated as a single cognitive entity, akin to Hammer et al’s model (this volume) of coherent activation of coordinated resources. A learner’s repeated association of the same tools in different contexts creates in her mind a co-ordination class described by diSessa [10].

Implications of Model

Based on the contemporary views of transfer [3-6], we have constructed a model to characterize dynamic transfer of learning in an interview. Our model is based on the premise that students construct their responses to interview questions dynamically and often make things up on the spot. Our model is also consistent with Redish’s [7] two-level theoretical framework of associations and activations controlled by a learner’s epistemic mode. We identify transfer as activation of associations between tools in the source (learning) and target (transfer) contexts. Epistemic resources are ‘meta-tools’ that control which associations a learner activates. For instance, a learner may selectively activate associations between the target scenario and classroom knowledge and ignore her everyday experiences because her epistemic resource directs her to see knowledge as propagated from authority and not created by her based on her everyday experience. Based on the external input, including meta-messages from the interviewer, a learner may be primed into a particular epistemic mode. The view of transfer as a process of epistemologically controlled activation of associations between source (learning) tools target (transfer) tools is useful in characterizing dynamic transfer in an interview.

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