Q540 Draft, Ji Son

Teachers want their students to abstract beyond specific learning instances and generalize to new situations. But in order to go beyond a specific problem about work-energy in a spring system to new work-energy systems, most cognitive theorists have posited an abstraction similar to the symbolic abstractions that physicists use. When a student learns a symbolic abstraction, does that automatically lead to generalizable learning? Research on this issue has shown time and time again that novices often have great difficulty transitioning from symbolic abstractions to new problems. However, well-developed abstractions are the mark of expertise, as is proper generalization …

The idea that abstraction of relevant information takes place over learned instances is common in both perceptual and conceptual models of cognition. Generally, there is a notion in cognitive science that perception is low-level input and conception is high-level representations. In such discussions, cognition, at its core, is computation with an input, internal representations and processes, and an output. In such a model, having the proper abstractions really means having the right kinds of representations/processes such that appropriate input can lead to appropriate output. First I will talk about this classic input-processing-output model and the implications it has on educational theory. Then I will talk about a more integrated approach to cognition and its impact on education.

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New directions in cognition: Integrating perception and conception

There are a number of new approaches that have taken a more integrative approach to the input-representation-output model. In general, the classic model would have separated some of the idiosyncrasies of particular sensory input from high-level computation, embodied approaches keep sensory information even when it seems unnecessary to the problem at hand. If learning is experienced in particulars, in order to generalize beyond those instances, different approaches ignore and highlight certain aspects of that experience. Classic computation ignores sensory information that embodied theories do not immediately discount.

Embodied approaches offer a radically new set of information since the human mind considers some features relevant even though from a computational analysis of a problem, such features may seem irrelevant. This should be of interest to theories of abstraction because it calls into question what information gets preserved. Traditional lines separate relevant “high-level” properties from irrelevant “perceptual” properties implying that the lofty concepts of mathematics, science, and humanities should dampen or strip away properties that are irrelevant to the problem. But actual cognition doesn’t seem to make such clean distinctions. For example, adding 5 roses and 3 daisies has the same high-level mathematics of adding 5 roses and 3 vases, but people prefer the former to the latter (Bassok, 2001). We see that abstraction, in the human mind, does not *have to* be about computational analysis. If we take Brooks’ warning seriously, we should admit that an input-representation-output model could lead to a wrong sort of abstraction, such as separating perceptual properties from conceptual ones.

Research has shown that conceptual expertise (marked by improved performance on a wide battery of tests in a domain) often results in perceptual changes such as initially different items becoming more similar and vice versa along with changes in memory (i.e. chunking), attention, feature-processing, and other typically “perceptual” processes

(Goldstone, 1998; Goldstone & Barsalou, 1998; Kellman, 2002). One way to understand these changes is by positing that conceptual changes have a top-down effect on perceptual processes. But the obvious question from an educator's perspective is this: how did such influential concepts get acquired in the first place? Goldstone and Barsalou (1998) offer different perspective on 'top-down processes' that is better equipped to answer the educator's question: conceptual processes are a product of perceptually grounded experiences and bear that heritage. We experience the world through our body so in some sense, embodied theories are not surprising when they claim that our bodies may play a part in the resulting abstractions of those experiences. From an education point of view however, although the direction of influence from concepts to percepts is interesting – when one's goal is to teach generalizable abstractions – more relevant is the potential influence from perceptual training to conceptual expertise: can "low-level" training lead to "high-level" learning?