**Cognitivist Theories III: Case Based Reasoning** (A Hitchhiker's Guide to Learning Theory)

**Patrick Parrish, WMO**

**Background**

When we looked at Cognitive Load Theory, we talked a little bit about long term memory, but nothing about what that looks like, how it's structured, and what is really stored there.

Is long term memory like an well organized file cabinet? Or is it just an elaborate web of ideas somewhat randomly connected? Or is there some other order to it? If so, what gives it order? What are the connections like?

Cognitive psychologists suggest that we store knowledge in "schemas," which is a way to describe how pieces of information are intricately connected to one another in complex web-like structures that allow us to recall things in a variety of ways. Connections can define logical relationships. For instance, they might say that one piece of information is a definition or an example of another piece, is a characteristic of it, or names a situation when it can occur. They might also connect an idea to its visual representation or connect it to visual examples. Connections might also involve analogies or metaphors. But as rich as they are, schema's don't seem to explain it all.

In the 1970's, researchers came up with the idea that we also stored knowledge as "scripts," or descriptions of how to behave or think when we find ourselves in certain situations. Schemas are like declarative knowledge, and scripts are a bit like procedural knowledge. But there is something different about scripts. They aren't specific procedures. They can sometimes be more like definable situations that trigger you to expect certain things and behave in certain ways. Scripts trigger you to activate certain schemas as well. Think about how differently you think and act in a formal dinner versus a gathering at the pub, for example, even if the exact same people are involved in both events. Each of these situations calls for its own schema and triggers its own script.

Work on building artificial intelligence systems that mimick human performance led to the conclusion that we perform effectively because we not only store knowledge as schemas and scripts, but we seem to develop a collection of cases to guide us. We can make fast and effective decisions because we store thousands of cases in our long term memories that guide us in future actions. These cases are like stories, and contain a setting, people who have goals and who take action, expected results, outcomes, and explanations that link goals and the means used to achieve them.

In fact, research has shown that professionals who work in high impact situations reason with cases all the time, and not by making purely logical decisions. For example, fire fighters, who have to make split-second decisions to save lives, begin by "measuring up" a situation and finding a case in their memory that seems similar to the current situation. They then often begin by immediately taking a course of action appropriate to the remembered case, and will adjust or shift their model case only when finding that the results they receive are no longer effective.

Key authors on case-based reasoning research and application to learning include Roger Schank and Janet Kolodner.

**Applications**

Case based reasoning does a good job of explaining how novices can rapidly progress to become experts, even while still in the process of developing the rich background knowledge of high-level experts. It explains how people can apply previous experiences to solve the new problems they encounter in new situations. Because it offers some detail about how memories of constructed and stored, it has many suggestions for learning design.

Some of these suggestions for education and training include (Kolodner, 2006):

- Learning happens best when learners are trying to achieve goals of interest.
- Learners need to interpret experiences in order for them to become well-articulated cases that will be accessible and useful in the future. They need to interpret to understand the strategies used, lessons learned, and explanations of failures and successes of cases.
- Learners need opportunities to apply remembered cases to allow further learning to occur, because this allows for reinterpretation of cases and the creation of strategies to adapt past cases to new situations.
- Learners can learn from the the well described cases of others as well as from their own experiences.
- Learners need feedback on their experiences to help them develop thecase memories. They need to understand why errors occurred and why their expectations might have failed.

Teaching in the context of cases is a strong instructional strategy, whether the case is a full-blown simulation, or merely described well enough to be learned from. Case-based reasoning argues for the value of on-the-job learning opportunities.

Professionals can also benefit greatly from collecting and sharing cases in repositories that can be browsed by a community. The creation of a case repository helps not only those who view them, but the persons who share the case, because it triggers the reflection necessary for the case to be well described for the repository.

Providing structure to stored cases triggers effective reflection and helps with retrieval of appropriate cases from the repository. A case entry should be structured by information such as:

- A description of the case in terms of time, location, and those involved.
- A description of the problems that were faced.
- The kinds of solutions attempted.

- What happened when the solutions were applied? What worked, and what didn't work?
- Potential new situations in which the case might be applicable.

**Limitations**

It might at times be difficult to decide how much background information is required before putting people into situations where they are engaged in cases. Some, like Roger Schank, will argue that being involved in cases, or in "goal-based scenarios," is the ONLY place people should be learning, but it is unlikely that such a radical approach is always necessary, and that as long as applications are discussed along with less grounded content, and as long as learners are engaged in frequent activities in which to apply learning, the principles of case-based reasoning are being used.

Case-based reasoning is a psychological theory about how individuals store and use memories, but most cases involve multiple people acting together to solve problems or make decisions. To better describe this kind of group action and group learning, ecological learning theories do a better job.

**References**

Kolodner, J. (2006) Case-based reasoning. In *The Cambridge Handbook of the Learning Sciences*, Sawyer, R.K. (Ed.) Cambridge: Cambridge University Press. (pp. 225-242)