Chapter II

Modes of Openness and Flexibility in Cognitive Flexibility Hypertext Learning Environments

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Introduction

The words openness and flexibility—the latter is the topic of this volume—are joined in the title of this chapter. We see them as two sides of the same coin—structure and process, as well as antecedent and consequent. Closed structures of *presentation* (how instructional materials are organized in delivery systems) and of *representation* (how knowledge is structured and operated upon in the mind) produce rigidity of thought and action. The antithesis of this rigidity is a kind of "openness-based" flexibility necessary for adaptive knowledge application, for transfer of knowledge to new situations, for situation-sensitive use of knowledge, and for the kind of world-fitting complexity of understanding that cognitive flexibility depends upon—and that the increasingly complex modern world of life and work needs now more than ever. Rigidity and oversimplification are rampant in learning and teaching (e.g., Feltovich, Coulson, & Spiro, 2001; Feltovich, Spiro, & Coulson, 1989, 1996; Spiro, Feltovich, & Coulson, 1996), but with the affordances of new media, we do not need to live complacently with this state of affairs (Spiro, in press).

The perspective of cognitive flexibility theory (CFT; Mishra, Spiro, & Feltovich, 1996; Spiro, Coulson, Feltovich, & Anderson, 1988, 2004; Spiro, Feltovich, Jacobson, & Coulson, 1992a, 1992b; Spiro & Jehng, 1990) enacts openness in many ways—in the theory itself and in the multimedia learning systems based on the theory (cognitive flexibility hypertext learning environments, CFHs). A recent overview of CFT can be found in Spiro, Collins, and Thota (2003).

A Non-Exhaustive Catalogue of Modes of Openness and Flexibility in Cognitive Flexibility Systems

Openness—and related flexibility—come into play in a wide variety of ways in learning systems based on CFT. Although we provide here the first *cataloguing* of a substantial sample of those ways that CFHs are characterized by forms of openness that promote flexibility, it is worth emphasizing that this is just a sample, that there are many more ways that each of the types listed below can be considered "open" and, in turn, create flexibility; and that there are more types than just these. It should also be noted that in this short chapter we will be talking only about characteristics of CFHs. We recognize that some of the features we discuss may be employed in other instructional design approaches in forms of varying similarity and difference to that used in CFHs.

Each of the following kinds of openness are found in *all* CFHs, with the exception of the ones that are specific to digital video cases, where the features are built into the subspecies of CFHs called EASEs (experience acceleration support environments). To see operative examples of many of the points that follow, see EASE-history (http://www.easehistory.org/), a system that uses presidential campaign advertisements to teach about U.S. history and core democratic values (Collins, Ramchandran, & Spiro, in press).[1]

The Foundation: Complex, Open, and Flexible Habits of Mind

Most important of all in fostering more flexible thinking is the establishment of appropriate habits of mind (ways of thinking, worldviews, mindsets, and so on that *prefigure* the *kinds* of knowledge that will be built by an individual). People too often adopt a knowledge stance that we have characterized as the reductive world view, made up of a number of Reductive Biases (Feltovich et al., 1989, 1996, 2001; Spiro et al., 1996, 1988, 2004). This is a tendency to see the world as made up of events and phenomena that are orderly, predictable, decomposable into additive elements, non-contingent, and well structured, and accordingly to have personal epistemologies that see learning as best

accomplished by approaches that lead to representations that are simple and highly general (capturing a topic with a single schema, prototype example, set of general principles and definitions, etc.), compartmentalized or "chapterized," and so on. When these habits of mind are prevalent, the result is structures of knowledge that are relatively more closed and, as a result, inflexible in operation.

The alternative—necessary in complex and more ill-structured arenas of knowledge—counters the tendencies just described with approaches that foster the building of knowledge characterized by multiple representation, interconnectedness, contingency (context-dependence, a tendency to recognize when it is appropriate to say "it depends" and to acknowledge that many situations are not "either/or," but rather shades of gray in between). *All* of the kinds of openness built into CFHs, as outlined below, are intended to shift habits of mind from the relatively closed to the more open, as well as to build specific content knowledge that has various forms of openness.

Opening Up of Comparison and Contrast: Beyond Pairs

The latest versions of CFHs (EASE systems) permit video examples to be compared in pairs on the screen. However, an important innovation has been the ability to set up results from multiple theme searches in each of four quadrants. Four-way comparisons open up categories to reveal subtle but important differences (e.g., "example one is kind of like example two in one way, but like examples three and four in yet other ways, even though all are similarly categorized")—and these nuanced differences are a basis for flexible application of knowledge in situations that also differ from each other in subtle ways. (An even greater expansion of the notion of comparison and contrast is found in CFH/EASEs' use of as many as a dozen rapidly comparable short versions of larger, overlearned video cases to permit a many-times increase in the number of comparisons that can be made in a relatively short amount of time. This is a key feature promoting *experience acceleration* in these new systems).

Crossroads Cases

Instruction in CFHs begins with carefully chosen examples that are rich in the lessons they teach, and that we call "crossroads cases." The lesson for openness is that events in a knowledge domain are not just examples of *one* thing, but rather involve the intersection of multiple concepts and are amenable to a continuing process of making additional interpretations (all of which require justification, of course). Cases, occurrences, events, and examples are open, and therefore they are precedents/experiences that act as a basis for future knowledge assembly in a wider variety of ways—thus the openness of individual cases promotes *flexibility*.

Many Cases

CFHs employ large numbers of cases, opening up the space of possible precedents/prototypes for greater *flexibility* in later knowledge application.

Furthermore, the fundamental organizing unit of CFHs is the *mini-case*. Larger cases are broken into several small segments so that coding of the CFH can be based on unique local properties rather than only those of the larger case they are drawn from, which would reduce the coding to a common denominator (which would miss much that is important) or, at the other extreme, include too much that applies only to a small region within a larger case and thus is misleading about the case as a whole. (Structuring in small segments also permits a *new incrementalism* of instructional sequencing in which one can begin learning with bite-size chunks of cognitively manageable complexity that establishes appropriately complex habits of mind from the beginning of instruction without overwhelming learners.) By breaking cases into a set of mini-cases, the number of examples worked with is greatly increased, further opening the space of possible prototypes for future action and providing many more opportunities for relating new instances to old ones—a many-fold increase in the bases for *flexibility*.

Conceptual Variability

One of the first instructional moves in any CFH is a conceptual-variability search. By clicking on a concept or theme, one finds a variety of real-world examples that illustrate that theme. The lesson that is immediately taught is that complex concepts do not have a denotative semantic core that *limits* their possibilities for application, but rather are governed by family resemblance relations. The conceptual-variability search illustrates the variety of ways the concept is *used*. This opening up of the range of possible uses of a concept in turn enables learners to use it in more different ways—that is, to employ the concept with greater *flexibility*.

Multiple Higher-Order Conceptual Themes

CFHs always employ multiple ideas "at the top." That is, we analyze the subject area to identify several different concepts that different experts have proposed as the "most important and central." And then we use them *all*. By opening up the topmost structure of a domain and providing learners with multiple entry points, each a candidate for "best superordinate concept," the chances of being able to optimize the prior knowledge activated to fit a new context is greatly increased—and situation-sensitive *flexibility* in applying knowledge is enhanced.

Multiple Theme Search: Playgrounds for Combining Ideas

CFHs permit searches for examples that illustrate the *combination* of concepts or themes. This allows for learners to form increasingly more sophisticated hypotheses about the subject area they are studying, the problem they are trying to solve, or the essay they are trying to write. The CFH acts as a kind of Combinatorial Idea Playground, all the while tied to actual occurrences (to insure that the ideas do not end up in the clouds, unconnected to realities on the ground). This permits a many-times expansion of the ways material can be organized, and this opening up of the organizational space enables a great increase in the *flexibility* with which material can be conceptually captured and later deployed.

Multiple Interconnectedness

By having a large number of mini-cases coded with a large number of conceptual themes, CFHs automatically produce highly interconnected structures that intertwine along multiple dimensions. This produces a huge number of possible retrieval routes in memory and possibilities for *flexible* knowledge assembly in new contexts, as situational information 'carves out' alternative paths through the Web-like representation.

Nonlinear Juxtaposition

A basic feature of all CFHs is that they create juxtapositions, sometimes quite unexpected ones, of cases that diverge from ordinary conceptual category membership. These "jumps" are the result of an opening of the organizational space, and this flexibility of organization instills habits of mind of *flexibility,* showing learners that they need not be bound by preestablished "lines of thought."

Perceptual Overlays to Open Perception

Some CFHs for digital video cases (EASE systems) employ various kinds of perceptual overlays to open and deepen perception. For example, when learners tend to watch one part of a video scene to the exclusion of other parts, we show the scene again, this time perhaps in slow motion and with spotlights on the neglected parts. People quickly get the message that what they first see is not all they can and should see—and they develop the habit to look more closely, and then to look again to see more.

When we find that people accept what they see uncritically, we use editing effects to cause the appearance of the video image shattering into fragmented shards, accompanied by a sudden loud noise—dissonance is created and complacent viewers are shaken out of their too great ease with what they think they are seeing. Again, habits of mind are hard

to change, and strong measures are required to capture their attention, make them realize they are seeing too simply, and show them that they are capable of seeing more if they look harder and with fewer blinders on.

Sometimes we have learners associate musical soundtracks that correspond to conceptual stances (as people naturally associate certain kinds of music in a film with suspense, for example), and then play the same video scene with different soundtracks. Learners quickly see that a scene, say from a classroom, is very much *open* to interpretation. (We do similar things with color filters, in much the same way as was done in the film, "Traffic.")

These are just a few of the ways that CFT uses perceptual enhancements to open up perception (and, incidentally, to reduce cognitive capacity demands). And the more one sees in a case, the more ways that case can be interpreted. As a result, there is a greater range of future uses to which the knowledge acquired from the case can be put—an important source of *flexibility*.

Opening Time

We are too often bound by temporal adjacency—events that occur near each other in time are easily related to each other, while those that are more temporally distant are less likely to be connected in our knowledge representations. CFH/EASE systems employ a convention for the placement of picture-in-picture videos to more organically connect events that have distant antecedents and consequents (with the former occurring in the lower left of the screen and the latter in the lower right of the screen, as an example of part of the time-representation scheme). By opening time, we increase the opportunity to form connections *flexibly*.

Conclusion

Various modes of openness in learning environments based on cognitive flexibility theory have been presented. The more ways that presentation formats and knowledge representations converge to promote open rather than closed thinking (though never in an "anything goes" manner—there must always be a warrant for any "opening" of representation), the greater the flexibility in future knowledge application that will result. This will be due in part to the greater opportunities for flexible knowledge assembly that open knowledge structures permit; but it will also be due to the more complex and flexible ways of thinking that will be formed and begin to become habitual. The result is the creation of mindsets that perpetuate the development of flexibly applicable knowledge and that eventually do not depend upon external support from computer learning environments—habits of mind that are the basis for independent, adaptive learning. And given the widespread bias toward rigid and oversimplified ways of thinking, the value of any learning approaches that combat that powerful trend cannot be underestimated—the reductive bias must be combated with all the resources that random access technologies can offer.

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Endnote

[1] For access to other systems that have a fuller set of features, send a note requesting URLs and a password to ***.