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Building learning sequences: Concept coding and analysis

Concept coding

Lectical scores position each sample of text along Fischer's skill scale; however, since scoring requires that the analyst "look through" the conceptual content of texts, these scores reveal nothing about the *particular* meanings contained in the texts. In other words, scores assess the level of an argument, but not what the argument is about. Whereas scoring involves looking through content to observe structure, concept coding focuses directly on content. This means paying attention to what is said (particular meanings) rather than how it is said (structure). To insure that concept coding and complexity analyses are independent, different analysts conduct each type of analysis.

Texts are coded at various levels of specificity. We refer to these as *levels of analysis*. These levels are typically represented by 3 or 4 conceptual categories, referred to as domains, themes, sub-themes (when they emerge), and concepts. These are conceptualized as follows:

Domains

Domains are the broadest category. A domain is a very general area of knowledge or collection of skills with some common element. Domains should be circumscribed by the logical or inferential relatedness of their elements (e.g. connections between concepts). Moreover, because domains are defined via inferential connections it should be recognized that domains shade into one another and are often circumscribed purely for heuristic purposes. Nevertheless, domains are not arbitrarily circumscribed. For example, while morality and leadership share many concepts, leadership and physics clearly do not.

Themes

The themes of a given domain are the overarching conceptual categories that can be traced from the representations tier to the principles tier. These themes represent a relatively broad conceptual strand, subsumed within a more general domain, and circumscribed from the inside by the closeness of inferential relations among their conceptual elements. Themes often represent the same overarching concepts that experts employ to define a given domain, but this is not always the case. In physics, we identified the energy concept as a theme. In our leadership research, vision constituted a theme.

Sub-themes

The sub-themes of a domain are conceptual categories that span several developmental levels and are subsumed under themes. It is particularly useful to identify and work with sub-themes in exceptionally rich and complex domains where it can be difficult to "see the forest for the trees." Because sub-themes are subsumed under themes, they represent more narrowly defined conceptual strands. For example, in physics, we identified *motion* as a sub-theme of *energy*. In the leadership domain, *problem solving* was treated as a sub-theme of *cognition*.

Concepts

Concepts are the conceptual elements of propositions, assertions, or arguments that are embedded in words or phrases. For example, the following statement contains several concepts: "Science is not always right, because scientists are people and people make mistakes." Here, concepts include: *science can be wrong*, *people make mistakes*, and *scientists are people*. These concepts are embedded in more general themes or sub-themes such as doubt concerning scientific truths, and limitations on humans' ability to know. Concepts can often be broken down into more specific elements. Part of the process of building a coding scheme involves determining what level of analysis will be targeted.

Themes, sub-themes, and conceptual categories each provide information that can inform our understanding of development in a given domain. Orienting to the themes and sub-themes present in the data provides a general picture of the domain—its major issues, problems, skills, and topics. Orienting to concepts provides a more intricate and detailed picture of the domain, offering insight into the variations and trends in respondents' constructions. Different levels of content analysis can be adopted, depending upon one's research questions and objectives. Good developmental analyses should ultimately focus on conceptual categories, because it is at this level that the subtle differences in meaning at adjacent developmental levels can best be captured.

Most of DTS' work is phenomenological, in that categories are most often created from that which respondents tell us is relevant to a domain. However, DTS' methods can be employed using conceptual categories that are partially or wholly generated by experts or guided by theory. It is crucial that borrowed categories embody fine enough distinctions in meaning to allow the detection of subtle developmental differences. The process of concept coding should yield a clear sense of the ideas that comprise the content of the concepts and skills targeted by a particular instrument. (The concept codes generated for use in this study can be found in Appendix 1.)

Refinement

After the coding has been completed, spreadsheets are created to facilitate examination of the empirical relation between codes and developmental phases. These spreadsheets reveal the distribution of concepts across and within developmental levels, and help analysts to identify the differences that are related to developmental change.

Before the analysis can be conducted, coding categories often must be refined, by collapsing similar codes into increasingly general categories. During this process, we take great care to preserve subtle differences in meaning. For example, on the *play* sub-theme in phase 7:2 in our study of evaluative reasoning about education, different children claimed that a good thing about school is that children get to:

- play outside
- have recess
- play with their friends, or
- play a specific game, such as hide-and-seek or snakes & ladders.

In the original coding scheme, these were given separate codes. After establishing that all of these assertions were made for the first time by children performing in phase 7:2, they were collapsed into the category: "At a good school, you get to play." On the other hand, assertions that at a good school you should

- partly play and partly work, or
- do some fun things

were not observed until phase 8:1. Consequently, they were collapsed into a separate category: "At a good school you should work *and* have fun/play."

Many codes are assigned to performances from multiple complexity orders. For example, in our study of evaluative reasoning about education, the category, “At a good school you get to play outside,” appeared from 7:2 through 8:3, while the category, “In a good school you have fun,” appeared at every phase represented in the sample.

Several rounds of refinement are often required to produce the concept categories that inform a given learning sequence.

Concept analysis: building learning sequences

The concept analysis phase involves a process of rational reconstruction, an inductive procedure combining: (1) the empirical relation between concepts and complexity levels, (2) the way concepts are embedded in the original texts, and (3) general knowledge about developmental structures. Figure 1, below, represents the overall process and combination of data analytic procedures that produce learning sequences.

Level descriptions versus level definitions

Descriptions of the reasoning associated with Lectical phases are *not* intended as level definitions. This is an important distinction between the approach DTS takes and those taken by developmental researchers who have described conceptual development in single domains.

We think of complexity levels as orders of hierarchical complexity and identify them by referencing structural, rather than conceptual, attributes of performances. This is because the particular conceptualizations embedded in a given performance can be explained by a range of factors beyond the complexity level of the performance.

However, by rigorously separating analyses of complexity level and conceptual content, clear and persistent evidence of a strong relation between conceptual content and complexity level in several knowledge domains has been uncovered. This relation makes it possible to describe the pathways through which individuals acquire important concepts.

The descriptions of reasoning produced with this process should not be thought of as level definitions. They are descriptions, and as such, they are subject to revision as new evidence about the conceptual content of a given thematic strand becomes available.

You can learn more about our broad methodological approach—*developmental maieutics*—from our publications, which are posted on the DTS website.

Figure 1: The process of constructing learning sequences