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ABSTRACT

This paper reports on an empirical study of educators' perceptions of learning concepts, reviews the cognitive learning literature, and argues for an expanded view of conceptual knowledge and its role in education and training. The report begins with discussions of changing views of concept learning and declarative and procedural components of concepts. A survey of 56 students in 3 graduate education classes is then described in which subjects were asked to respond to a scenario in which they are imagined to be teaching a sampling of concrete and defined concepts (glasnost, snow leopard, and justice) to college sophomores with no prior knowledge of the topic. The question for the students then is: What performances would serve as indicators that their students had really learned the three concepts? The broad array of concept performances listed by the subjects--339 for the three concepts--are summarized in four categories: definitions and defining attributes; examples and nonexamples; elaboration; and use--and an expanded notion of concept learning is presented. Five concept teaching strategies that include the declarative and problem-solving aspects of concept learning as well as procedural classification skills are then discussed. The strategies are: (1) teaching with analogies; (2) encouragement of learning strategies; (3) use and inference practice; (4) alternative strategies for classification performance; and (5) determining qualities of concepts to be learned. It is concluded that this way of looking at concepts takes into account the declarative and metacognitive components of concept learning and use, and it is recommended that the "intellectual skills" of concept classification be integrated with the "verbal information" that makes the concept meaningful, and with additional skills that encourage use and inference. (33 references) (BBM)

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ADULTS' PERCEPTIONS OF CONCEPT LEARNING OUTCOMES: AN INITIAL STUDY AND DISCUSSION

The purpose of this paper is twofold: (1) to report an empirical study of educators' perceptions of learning concepts, and (2) based on the study's findings and a review of cognitive learning literature, to argue for an expanded view of conceptual knowledge and its role in education and training.

Changing Views of Concept Learning

Concepts are essentially categories that people use to organize their worlds and give order and meaning to their experiences. People learn concepts both by interacting naturally with their environments and through school and formal learning experiences (Brown, Collins, & Duguid, 1989). Also, people often spontaneously invent concepts to solve local problems.

Over the past few years, several instructional design theorists have suggested revisions in the traditional view of concept learning (Tennyson & Cocchiarella, 1986; Wilson, 1986; Newby & Stepich, 1987; Tessmer, Wilson, & Driscoll, 1990). According to these researchers, the well-established "concept attainment" paradigm in instructional design literature (e.g., Markle, 1975; Merrill & Tennyson, 1977) does not take into account advances in cognitive psychology explaining how people acquire conceptual structures. Concepts should no longer be thought of as being completely defined by attributes-based definitions. Many concepts may be ill-defined or "fuzzy", and many concepts have rich connotations and shades of meaning whose understanding is necessary to make full use of the concept. Recommended instructional strategies include greater use of analogies , "prototype" examples, and learning strategies, and greater use of the concept in a variety of problem-solving settings.

Declarative and Procedural Components of Concepts

Historically, instructional design models have addressed a problem common in formal school settings, in which a definition may be learned by rote, and students are never required to actually use the definition to classify sample cases. Largely as a response to schools' preoccupation with inert, declarative

knowledge, instructional designers emphasized *classification* performance; that is, given a newly encountered case, can the student identify that case as being a member of the concept category? The roots of viewing concepts as classification skills can be traced back to Aristotle, and more recently, to Thorndike and Hull's laboratory studies on human learning. Basically, students capable of classifying new cases were said to know the concept. Gagne (1985), following Anderson's (1983) theory of cognitive learning, calls this kind of performance "pattern matching" and treats it as a kind of procedural skill. Like most procedural knowledge, concept classification performance can be acquired and refined through repeated practice with feedback. Example classification strategies form a major part of traditional recommendations for teaching concepts, such as the use of divergent examples, proceeding from easy to complex cases, highlighting key attributes, and providing explanatory or elaborative feedback to missed practice items.

Notwithstanding instructional design emphasis on procedural aspects, language experts have long understood that in addition to denotations (the set of cases the term refers to), terms or concepts also have connotations (the meaning or properties suggested by the term). A person who has learned what a sea otter is, for example, should be able to identify a sea otter from a harbor seal, but should also be able to tell us something significant about the animal. One could imagine a student narrowly trained to classify cases but lacking in declarative knowledge about the subject. Such a student could "use" the pattern-matching skills to identify cases, but may not have the least notion about what the classification *meant*. Equally disturbing, the lack of meaningful understanding about the category would inhibit the concept's effective use in most realistic problem-solving situations. The student would probably not understand when and where to use the concept spontaneously to achieve a particular goal, or to draw inferences from its meaning. An optimal learning of concepts, then, would seem to include components of both declarative and procedural knowledge, combined in a way that made the concept meaningful and usable in real-life situations.

Really Learning Concepts: A Survey of Educators

Persuaded that most educators would agree that both declarative and procedural aspects are important outcomes, we conducted an exploratory study to examine the kinds of learning indicators educators would accept as evidence of concept learning. We asked students (N=56) in three graduate

education classes to respond to the following scenario: You are teaching college sophomores of medium to above average intelligence with no prior knowledge of the topic. What performances would serve as indicators that students had really learned the concepts *glasnost*, *snow leopard*, and *justice*, representing a sampling of concrete and defined concepts. Subjects filled in blank spaces with their choice of learning indicators.

NUMBER AND TYPE OF CONCEPT LEARNING INDICATORS
(Total respondents = 56; responses = 339)

TOTAL	CONCEPT LEARNING INDICATOR
127	**Definitions and defining attributes**
62	Describe defining attributes
38	Give the definition
27	Describe the concept
66	**Examples and nonexamples**
38	Classify/recognize cases
28	Generate examples
62	**Elaboration**
45	Describe concept elements (not defining attributes)
5	Teach the concept to others
5	Relate the concept to other concepts
4	Distinguish between concepts by elements
3	Explain the concept
84	**Use**
22	Describe effects/implications
20	Use in a sentence/story
17	Solve problems using the concept
9	Critique situations and actions using the concept
9	Write a story about the concept
7	Role-play

A major finding is the broad array of concept performances that subjects listed. Table 1 summarizes the responses according to type of performance suggested. The 56 respondents generated 339 performances for the 3 concepts. Of those performances, 38 suggested concept classification following traditional instructional design models. However, a large number (217) of other performances like "discuss", "compare", "describe", "draw", "give an example" were elicited, suggesting the commonsense prominence of having a declarative understanding of the meaning of the concept. In addition, using the concept in a variety of creative ways, and drawing inferences from it were also thought to be valid indicators of concept learning. Eighty-four responses mentioned uses such as problem solving, predicting effects, role-playing, and using the concept in conversation or writing.

An interesting point made by several researchers (e.g., Howard, 1988) and confirmed by our study's findings is the schema-like role played by many concepts. Schemas, according to models of cognitive processing, consist of a whole network of related knowledge, centered around a particular setting or idea. Many concepts, such as 'justice' in our study, are rich in their associations with other concepts. The web of relations together may constitute a schema for that concept, so that concepts become schema-like in their complexity. While it is important to differentiate between the concept itself (the category and its basic meaning) and its full-blown schema, an understanding of how a concept is related to other knowledge can provide a basis for prescribing effective use of the concept for solving significant context-based problems. The instructional designer's emphasis of "using" concepts can then be expanded beyond classification performance to problem-solving and other divergent uses, such as making inferences and developing analogies. In order to make creative use of concepts, declarative, procedural, and *metacognitive* knowledge must be acquired by the learner. We would recommend an instructional design model that included these components with respect to concept learning as well as all learning outcomes.

New Methods for Teaching Concepts

The expanded notion of concept learning described above has definite implications for concept teaching strategies. Summarized below are several strategies that include the

declarative and problem-solving aspects of concept learning as well as procedural classification skills.

1. ***Teaching with analogies.*** Analogies enable learners to connect novel conceptual information with their prior knowledge, thus establishing a familiar structure for the new concept. Concept instruction through analogy can be so powerful that the proper analogy must be carefully chosen (Striley, 1988), and its boundaries (comparatives) to the concept explained (Feltovich, et. al., 1988).

Several theorists prescribe the use of analogies for defined (abstract) concept learning (Ortony, 1975; Newby & Stepich, 1987). However, analogies can also be used for concrete concepts such as "snow leopard." This is worth noting since most designers seem to forget that visual/aural/tactile information (R. Gagne's "concrete concepts") can be as complex and/or difficult to learn as defined concepts. Biederman & Shiffrar (1987) present an interesting illustration of this point. They cite an analogy used by chicken sexers, who cultivate their subtle identification skills over years of experience. To identify male chickens, their genitals are conceptualized as looking like a watermelon or a ball, while the female's look like an upside down pine tree (p. 643).

2. ***Encouragement of learning strategies.*** Various learning strategies can be invoked by learners to aid the encoding of concept information. Concept mapping and structuring (Jonassen, 1984; Vaughan, 1984; Tessmer and Jonassen, 1988) help students organize definitions, examples, and properties of concepts, as well as semantic/inferential relations among other concepts. For classification tasks, advance task instructions on learning and performance expectations can activate concept learning strategies in students (Ellis, et. al., 1986). If concept inference or use is an objective of the instruction, these advance instructions may help the learner to generate the proper problem-solving stance toward the content.

3. ***Use and inference practice.*** Programs such as the Higher Order Thinking Skills program (Pogrow, 1985) have successfully encouraged students to manipulate conceptual information by creatively using the concept in various symbol systems and contexts to broaden their meanings. For example, using the concept of reinforcement in lab experiments, teaching, and business contexts can broaden the learner's understanding of what reinforcement entails, which can promote the learner's transfer of the concept to contexts not originally studied (e.g. for self-management).

Using a concept in different symbol systems occurs, for example, when learners read about the social hierarchy of whales and draw sketches depicting their understanding of "hierarchy." This process of translating from one code to another -- in this case, verbal to visual -- has been termed *transmediation* (Suhor, 1982) and has assisted learners in gaining new insights and broadened understandings about concepts (Siegel, 1985).

Concept use instruction can proceed through several stages. Learners can begin by paraphrasing the concept definition of attributes (R. Anderson, 1973) and conversing about the concepts (Markle, 1975; Wilson & Tessmer, 1989), then move to utilizing the concept in conversations and other communications, and finally to using the concept with other declarative or procedural knowledge to solve problems (Wilson & Tessmer, 1989).

4. ***Alternative strategies for classification performance.*** A variety of alternate presentation strategies can be used to supplement the standard definition-plus-examples/nonexamples strategies used in example classification training. Many of these strategies have been advocated by instructional theorists over the years.

For example, displaying coordinate concepts in structural outlines such as concept trees has facilitated coordinate concept classification (e.g., Tessmer & Driscoll, 1986), and may be particularly effective with adult learners (Bower, 1970). For classification practice, concept games and simulations are a little-used strategy that puts the learner into scenarios that elicit classification performance in ways that differ from standard concept example practice (Tessmer, Jonassen & Caverly, 1989). Particularly, concept simulations mimic the real-world situations in which the learner will use concept classification, increasing the probability of transfer. To create concept examples/nonexamples that maximize generalization and discrimination, the Rational Set Generator (Driscoll & Tessmer, 1985; Tessmer & Driscoll, 1986) can be used to design sequences of coordinate concept examples and nonexamples.

Hierarchical displays facilitate the learning and organization of the declarative component of concept classifying, while rational sets, games and concepts facilitate mastery of the classification skills of concept learning (E. Gagne, 1985). When used with analogies, and use and inference practice, the aforesaid interventions extend what Reigeluth (1983) would call the meaningfulness of the concept.

5. Determining qualities of concepts to be learned. While the distinction between defined and concrete concepts is a well-established part of design practice, a more fine-grained analysis of concept qualities could lead to more appropriate instruction. The ***complexity*** of concepts is an important dimension to consider, for example. Complexity is determined by the amount and unfamiliarity of information to be learned to meet concept learning objectives.

Contrary to Newby and Stepich's (1987) emphasis on abstract (defined) concepts, concrete concepts may be as complex and difficult to learn as defined concepts, as indicated in the chicken sexing sample above. Concepts may also vary in their ***precision***; many everyday concepts are ill-defined or "fuzzy," defying standard definitional instruction (B. Wilson, 1986), such as concepts like "time" or "esprit de corp." Concepts may be ***relational, conjunctive***, or ***disjunctive*** (Bruner, Goodnow, Austin, 1956), each requiring appropriate instructional support. Most important, designers must learn to classify concepts by the ***content*** and ***purposes*** of the instruction. The meaning of any given concept and its learning objectives frequently depend on these two factors, not upon a standard invariant meaning and standard classification performance. The way people use concepts is context dependent (Whitehead, 1954; Carroll, 1964; Barsalou, 1985). Thus, just as context is examined in a front-end analysis for large-scale instruction, so context should be analyzed when teaching concepts. What are the different uses of the concept by someone who "really understands" it? What are the variable subjects or situations in which it will be used? These are context analysis questions.

Conclusion

In this paper, we have presented an exploratory study that seems to confirm a correspondence between adults; perceptions of concepts and emerging views based on cognition models. This way of looking at concepts takes into account the declarative and metacognitive components of concept learning and use. Implications for instructional design have been outlined. The paper is largely a response to traditional concept teaching models that focused nearly exclusively on the procedural components of concept use. Using R. Gagne's (1985) taxonomy of learning outcomes as an example, we are recommending that the "intellectual skill" of concept classification be integrated with the "verbal information" that makes the concept meaningful, and to

additional skills that encourage concept use and inference. Concepts taught in this broader way will be more likely to be used in realistic performance situations.

The obvious danger in broadening the view of concepts and concept teaching is that the notion will become ill-focused and lack prescriptive power. We believe that, on the contrary, a broader approach to concept learning can help bring our instructional models back into alignment with everyday teaching and learning. A continuing effort to articulate instructional strategies such as inferences, simulations, scenario-based instruction, and case studies will help concepts come alive to learners.

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