

## Schema Theory: Using Cognitive Structures in Organizing Knowledge

A schema (pl. schemas or schemata) is an individual's collection of prior knowledge that provides a context for meaningful interpretation of new information (Anderson, 1984). Schemas have been defined as abstract knowledge structures that organize vast amounts of information (Gagne, Yekovich, & Yekovich, 1993) and as cognitive constructs that organize information into meaningful systems (Anderson, 2005; Schunk, 2004). Bruning et al (2004) identified schemas as scripts or representations for events that provide plans for action in particular situations, such as a student having a script to prepare for a test. Scripts contain procedural knowledge and often have information about physical features, people, and typical occurrences. As individuals encounter new information, they add this information to their schemas, which are organized into different interrelated categories (Cooper, J., 2006).

Schemas are personal and individually organized, e.g., two individuals can have two different schemas for the same information. If new information can be related to existing schemas, using these schemas can help students develop expectations about the nature of the new information, attend to its most important elements, and fill in gaps where information is implied rather than stated explicitly. For all of this to work optimally, an individual's schema for a particular piece of information must be well-organized, easing information retrieval, and based on accurate information. When it is not, i.e., not well-organized and inaccurate, the new information will itself be poorly organized and received in an inaccurate way. Bartlett (1932, 1958), a British psychologist, is identified as first proposing the concept of schema suggesting that memory takes the form of schema which provides a mental framework for understanding and remembering information. In a series of studies on the recall of Native American folktales, he observed that many of the recalls were inaccurate, but involved the replacement of unfamiliar information with something more familiar. The remembrances also included many inferences that went beyond the information given in the original text. To account for this, he proposed that people have schemata, or unconscious mental structures, that represent an individual's generic knowledge about the world. It is through schemata that old knowledge influences new information.

### Information and Memory

Long-term memory has been usefully compared to a library of books or set of file folders. The way students retrieve information is said to be similar to the process they use to locate and check out a book or find a folder. The process of retrieving information from long term memory, however, is not always precise. When a student searches through his or her long-term memory storehouse of information, the student doesn't always find the book or folder desired, or might find the desired book or folder, but discover that some pages are not intact. This is often based on the completeness of the informa-

tion and/or how the information was filed or stored in the first place.

Anderson (1977, 1978), an educational psychologist, played an important role in introducing schema theory to the field of education. Schema theory is based on the belief that every act of comprehension involves one's knowledge of the world developed up to that point. Schemata provide a form of representation for complex knowledge. The construct, for the first time, offered a principled account of how old knowledge might influence the acquisition of new knowledge. Schema theory lays out a picture of how people organize the truly enormous amount of background knowledge which they accumulate about the world. Such knowledge is organized into mental units, called schemas. When people learn, when they build knowledge, they are either creating new schemas, or linking together preexisting schemas in new ways. Schema theory states that, when students reconstruct information, they fit it into information that already exists in their minds. As they attempt to retrieve information from their long-term memory, the searches sometimes are not very exact and they don't always locate precisely what they want. When asked to retrieve information, students often fill in the gaps between their fragmented

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memories, sometimes not well organized and/or with incorrect information, with a variety of accuracies and inaccuracies. In the end, sound learning can go forward well or be misdirected, based on what a student has not organized or learned well previously.

### Schemas and Learning

Building on memory and schema theory, what application does this have for the classroom teacher? The answer, in practicality, is quite simple, while in practice, quite complex. Teachers need to teach their students how to store information for efficient and accurate retrieval; they must guide their students in the development of accurate schemas and teach them so that they logically build upon knowledge already gained.

Information that does not accurately fit into a student's existing schema about something may not be understood, or may be understood incorrectly. In schema theory, students actively build schema and revise them in light of new information. Each schema depends on the student's prior experiences and cognitive processes. Most schema theorists hold that there is not just one body of knowledge available to students at any given stage of development, but, rather, a network of context-specific bodies of knowledge that students apply to specific situations

(Widmayer, n.d.). Situation-specific schemas help to explain the difference between expert and novice interpretation of knowledge. Having more complex, developed schemas in a particular subject area, experts can function better in any given domain than novices with no schema or inadequate schemas, to help them interpret new information.

How students acquire knowledge through schema theory is similar to Piaget's model of the process of cognitive development. In this model, 1) through *accretion*, students take in new information and assimilate it into their existing schema without making any changes to the overall schema; 2) through *tuning*, students realize that their existing schema is inadequate for the new information and modify the existing schema; or, 3) through *restructuring*, students create a new schema to deal with inconsistencies between the old schema and newly acquired information (Driscoll, 1994). Piaget's theory emphasizes the ways that schemas change as children develop and assimilate or accommodate new information. Bartlett's research (1932, 1958) suggests that, not only does information change children's schemas, their schemas may also affect the information that they learn. Students' prior knowledge and expectations may cause them to remember information in a distorted way as it fits into their existing cognitive frameworks (Sternberg & Williams, 2002).

### Schemas and Teaching

The most important implication of schema theory in teaching is the role of prior knowledge in processing. When people learn, they are either creating new schemas or linking together preexisting schemas in new ways. For students to effectively process information, their existing schemas related to the new information need to be activated. This can be done by using outlines, organized activities, advanced organizers, meaningful materials such as handouts, guides, asking specific questions, etc. This activation stimulates prior knowledge and, in turn, students are better able to process the new information and link to it. In reading, for example, Miller (2002, pp. 71-72) notes that readers:

- activate their prior knowledge before, during, and after reading;
- use schema to make connections between the text and their lives, between one text and another, and between the text and the world;
- distinguish between connections that are meaningful and relevant and those that aren't;
- build, change, and revise their schema when they encounter new information in the text, engage in conversations with others, and gain personal experience; and
- use their schema to enhance understanding.

Teachers are encouraged to use analogies and comparisons in their teaching in order to draw attention to students' existing schemas and to help them make connections between existing schemas and new information (Armbruster, 1996). Teaching should focus on schema-building strategies, in particular strategies for building functional problem-solving schema, as a foundation for further developing the student's problem solving ability (Price & Driscoll, 1997). Teachers are advised to use familiar examples in their teaching rather than more conventional, abstract information. Instruction can facilitate schema-building by providing students feedback in the form of numerous, fully worked out and explained examples that explicitly guide them in building their own schemas. To assist students in their learning and to capitalize on connecting to a student's prior knowledge, the teacher's materials should be organized according to conventional structures that students may already be familiar with. Too, teachers must acknowledge the cultural differences in their students, in particular as these differences impact their students' familiarity with their teaching materials, the examples that they give, and the contexts for learning that they establish in their teaching.

### References

- Anderson, J. (2005). *Cognitive psychology and its implications* (6<sup>th</sup> ed.). New York: Worth.
- Anderson, R. (1984). Role of the reader's schema in comprehension, learning, and memory. In R. Anderson, J. Osborn, & R. Tierney (Eds.), *Learning to read in American schools: Basal readers and content texts*. Hillsdale, NJ: Erlbaum.
- Anderson, R. (1978). Schema-directed processes in language comprehension. In A. Lesgold, J. Pellegrino, S. Fokkema and R. Glasser (Eds.), *Cognitive psychology and instruction*. New York: Plenum.
- Anderson, R. (1977). The notion of schemata and the educational enterprise: General discussion of the conference. In R. Anderson, R. Spiro, and W. Montague (Eds.) *Schooling and the acquisition of knowledge*. Hillsdale, NJ: Erlbaum.
- Armbruster, B. (1996). Schema theory and the design of content-area textbooks. *Educational Psychologist*, 21, 253-276.
- Bartlett, F. (1932). *Remembering: An experimental and social study*. Cambridge: Cambridge University Press.
- Bartlett, F. (1958). *Thinking*. New York: Basic Books.
- Bruning, R., Schraw, G., Norby, M., & Ronning, R. (2004). *Cognitive psychology and instruction* (4<sup>th</sup> ed.). Upper Saddle River, NJ: Merrill/Prentice Hall.
- Cooper, J. (2006). *Literacy: Helping children construct meaning* (6<sup>th</sup> ed.). New York: Houghton Mifflin Company
- Driscoll, M. (1994). *Psychology of learning for instruction*. Boston: Allyn & Bacon.
- Gagne, E., Yekovich, C., & Yekovich, F. (1993). *The cognitive psychology of learning* (2<sup>nd</sup> ed.). New York: Harper-Collins.
- Miller, D. (2002). *Reading with meaning*. Portland, ME: Stenhouse Publishers.
- Price, E., & Driscoll, M. (1997). An inquiry into the spontaneous transfer of problem-solving skill. *Contemporary Educational Psychology*, 22, 472-494.
- Schunk, D. (2004). *Learning theories: An educational perspective* (4<sup>th</sup> ed.). Upper Saddle River, NJ: Merrill/Prentice Hall.
- Sternberg, R., & Williams, W. (2002). *Educational psychology*. Boston: Allyn & Bacon.
- Widmayer, S. (n.d.). *Schema theory: An introduction*. George Mason University.

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