Schema Theory: An Introduction

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Key concepts of the theory

All human beings possess categorical rules or scripts that they use to interpret the world. New information is processed according to how it fits into these rules, called schema. These schema can be used not only to interpret but also to predict situation occurring in our environment. Think, for example, of a situation where you were able to finish another person's thoughts, or when someone asked you to pass that "thingamabob." Schema Theorists suggest that you used your schema to predict what you conversation partner was going to say and to correctly interpret "thingamabob" as the hammer needed to nail something into the wall.

Information that does not fit into these schema may not be comprehended, or may not be comprehended correctly. This is the reason why readers have a difficult time comprehending a text on a subject they are not familiar with even if the person comprehends the meaning of the individual words in the passage. If the waiter in a restaurant, for example, asked you if you would prefer to sing, you may have a difficult time interpreting what he was asking and why, since singing is not something that patrons in a restaurant normally do. However, if you had been to the restaurant in the past and knew that it was frequented by opera students who liked to entertain the clouds, you would have incorporated that information into your schema and not be confused when the waiter asked if you'd prefer to sing.

In contrast to Ausubel's Meaningful Receptive Learning Theory, the learner in schema theory actively builds schema and revises them in light on new information. Each individual's schema is unique and depended on that individual's experiences and cognitive processes. Ausubel postulated a hierarchical organization of knowledge where the learner more or less attached new knowledge to the existing hierarchy. In this representation, memory is driven by structure as well as meaning. Knowledge in Schema Theory, however, is not necessarily stored hierarchically. In fact, it is meaning-driven and probably represented propositionally, and these networks of propositions are actively constructed by the learner. For example, when we are asked to recall a story that we were told, we are able to reconstruct the meaning of the story, but usually not the exact sentences– or even often the exact order– that we told. We have remembered the story by actively constructing a meaningful representation of the story in our memory.

In contrast, to Piaget, most schema theorists postulate that there is not just one body of knowledge available to learners at any given stage of development, but rather a network on context-specific bodies of knowledge that learners apply to specific situations. For instance, in the example above where someone asks for a "thingamabob", the listener would need to have a "hammering" schema to correctly infer that is what is needed. Situation-specific schema help to explain the difference between expert and novice interpretation of knowledge; experts, with more complex developed schema in a particular subject area can function better in any given domain than a novice with no schema or an inadequate schema to help them interpret and react

to new information. Since these schemas are context specific, they are dependent on an individual's experience with and exposure to a subject area rather than simply "raw intelligence." (See references to expert-novice studies on page 155 in Driscoll).

Schema are important not just in interpreting information, but also in decoding how that information is presented. Schemata can be reflected in text structures, for example, (Driscoll, 1997; Halliday & Hassan, 1989). Readers use their schematic representations of text (narrative, compare/contrast, cause/effect, etc) to help them interpret the information in the text. Schema reflecting how information is presented can also be culturally determined. Robert Kaplan (1966) stated that the structure of formal argumentative essays is culturally determined and that therefore second language writers and readers must be aware not only have sufficient command of their second language but also of the textual structures in their second language.

The way that learners acquire knowledge under schema theory is quite similar to Piaget's model of the process of development. In essence, there are three different reactions that a learner can have to new information: accretation, tuning, and restructuring. In accretation, learners take the new input and assimilate it into their existing schema without making any changes to the overall schema. Tuning is when learners realize that their existing schema is inadequate for the new knowledge and modify their existing schema accordingly. Restructuring is the process of creating a new schema addressing the inconsistencies between the old schema and the newly acquired information. Unlike Piaget, however, schema theorists do not see each schema as representative of a discrete stage of development, and the processes of accretation, tuning, and restructuring occur over multiple domains in a continuous time frame.

In addition to schema, learners are also thought to have mental models, which are dynamic models for problem solving based on a learner's existing schema and perceptions of task demand and task performance.. According to Driscoll (1994) "what this means is that people bring to tasks imprecise, partial, and idiosyncratic understandings that evolve with experience (page 152).

Corresponding instructional strategies

Several instructional strategies logically follow from schema theory. The most important implication of schema theory is the role of prior knowledge in processing. In order for learners to be able to effectively process information, their existing schemas related to the new content need to be activated. The importance of schema-activation can be seen in the fact that "Stimulating Recall of Prior Knowledge" is the third stage in Gagne's nine events. Correspondingly, teachers of reading have found that activating a learner's schema enables them to better process information that they are reading. Therefore, many advocate teaching learners metacognitive strategies designed to activate one's schema before reading, such as reading heading and the title, looking a visuals in the text, and making predictions based on the title and pictures.

Armbruster (1996, as quoted by Driscoll) also encourages the use of analogies and comparisons to order to draw attention to learner's existing schema and to help them make connections between existing schema and the new information. In terms of fostering students' problem solving ability, instruction should focus more on schema-building strategies, in particular strategies for building appropriate functional problem-solving schema, as a foundation for

problem-solving ability (Price & Driscoll, 1997). In addition, instruction should use "realistic, familiar scenarios in teaching problem-solving rather than more conventional abstract contexts." (Price and Driscoll, 1997). The authors (1997) also state that "instruction should facilitate schema building by providing learner feedback in the form of numerous fully worked out and explained examples or worksheets that explicitly guide learners in building their own schemata." Gagne and Glaser (1987, as quoted by Driscoll, 1994) also advocate explicitly teaching mental models to facilitate students' developing an appropriate schema.

Multiple schema-building experiences from multiple perspectives are also needed to help learners develop functional problem-solving schemas that they can successfully use to solve unfamiliar problems (or more accurately familiar problems in unfamiliar context). Therefore, "instructors and instructional designers should assume that problem-solving ability is cumulative not only over time but over numerous experiences." (Price and Driscoll, 1997)

Another important implication of schema theory is the recognition of role that culture and experience play in creating an individual's knowledge. Educators must pay attention to the cultural references in the material we present to our students and avoid potential cultural-biases. For example, students who have not grown-up in American culture may be at a disadvantage when asked to read and answer questions about George Washington on a standardized assessment test because, unlike American students, they have no preexisting George Washington schema that they can activate that will help them process the information they are reading more effectively.

Schema Theory also has implications for textbook design, and by extension design of other instructional materials. In order to facilitate student learning, material should be organized according to conventional structures that students may already be familiar with. In addition, designers should employ strategies to facilitate students' recall of related material, such as using analogies to draw connections between related content.

Effectiveness of the theory in achieving its learning goals

Current research, such as the study of student problem solving in familiar and unfamiliar context by Price and Driscoll (1997) and the study of the relative effects of familiarity with the topic and use of maps on student recall by Schwartz Ellsworth (1998) suggest that Schema Theory is a valid metaphor for explaining students knowledge structures and ability to recall information.

Price and Driscoll found that at the beginning of their 1997 study, 10.5% of subjects could solve a particular type of problem (a selection problem) in an unfamiliar context. However, 57.3 % of those involved in the study could solve a very similar problem in a familiar context.. The researchers then conducted three different treatments (prior exposure to the problem in a familiar scenario, repeated opportunities to solve similar problems in different context, and detailed process-oriented feedback) designed to help learners construct a function "problem solving" schema for solving selection problems regardless of context. The effect these treatments was not significant, leading the authors to conclude that "schemata exist and that they powerfully influence problem solving. . . However, there is no evidence that our subjects

spontaneously abstracted a useful schema while trying to solve the selection problems nor did the feedback conditions appear to promote such abstraction" (Price and Driscroll, 1997, p. 83).

Schwartz et al (1998) studied map-passage retention to determine which theory, Dual coding or Schema could better account for the higher level of retention demonstrated by learners who look at a map prior to listening to a passage. They concluded that the maps helped learners connect what they already know about an area to what they need to remember from the passage. However, they also found that "prior knowledge of geography is activated by the geographic propositions contained in a passage, with or without a map." (Schwartz et all, 1998, p. 65) Thus they were able to conclude that the improved recall manifested in learners using map of familiar geographic areas is due primarily to the effects of schema theory.

From the above small sample of schema theory research, it does seem that schema is a valid explanation for how learners process and interpret information. However, the Price and Driscoll theory also demonstrates a difficulty that must be overcome: it may well be the case that strongly situated schema make it difficult for learners to develop functional problem solving skills that are appropriate across knowledge domains. In addition, it appears that transfer of knowledge outside of the context in which is was originally acquired is difficult and may require that the learners are exposed to similar knowledge in numerous different context in order to eventually be able to construct less situationally-constricted schema (Price and Driscoll, 1997).

Schema theory, unlike some other learning theories such a behaviorism or cognitive dissonance, does not seek to explain the acquisition of only certain types of knowledge such as behaviors or attitudes. Rather instructional strategies based on it can be applied to any learning situation. The ability of the theory to explain how numerous different types of knowledge is learned and to suggest instructional strategies appropriate regardless of the type of knowledge also makes Schema Theory an effective theory for educators and instructional designers.

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