Knowledge Construction in Collaborative Science Writing: Strategic Simplicity, Distributed Complexity, and Explanatory Sophistication

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1 Introduction

In *The Sciences of the Artificial*, Herbert Simon (1996, p. 51) presented a parable about an ant:

We watch an ant make his laborious way across a wind- and wave-moulded beach ... Viewed as a geometric figure, the ant’s path is irregular, complex, hard to describe. But its complexity is really a complexity in the surface of the beach, not a complexity in the ant.

Simon used the ant’s path to introduce one of the themes of his chapter on human thinking: It emerges from the interaction between two elements. One is a limited capacity, short duration, working memory; the other is an environment rich in structured information.1 This rich structure allows humans to carry out complex activities using relatively simple strategies. This parable raises a question for the psychology of writing. Is the complexity of writing, like the path of the ant, largely a function of information structure in the environment? Or is it a function of sophisticated strategies internal to the writer? The present chapter addresses this question in relation to writing as a learning activity, in this instance, the writing of fifth grade students constructing an explanation of episodic acidification.

Cognitive psychology has most often explained writing primarily in terms of the complexity of the individual writer’s strategies and knowledge. Skilled

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1 H.A. Simon considered the “environment” to include both long term memory, and the physical and cultural world, in the sense that both are external to working memory.
writers have knowledge in long term memory about strategies, topics, audiences, language, and genre (e.g., Alamargot & Chanquoy, 2001; Hayes, 1996; McCutchen, Teske & Bankston, 2008). They deploy this knowledge using processes that include planning, self-regulation, and revision. These complex structures and processes have also been recognized in theories of writing to learn. To date, perhaps the most widely discussed theory has been the knowledge transforming model (Bereiter & Scardamalia, 1987; Galbraith, 2009a; Kellogg, 2008; McCutchen, Teske & Bankston, 2008; Scardamalia & Bereiter, 2006). It proposes that expert writers use a sophisticated strategy based on a dialectic between rhetorical problem solving and content problem solving. The writer defines rhetorical goals; to pursue these goals, he or she sets content sub-goals. To pursue these content goals, the writer engages in content problem solving, using operations such as inference-making and decision-making. This produces content propositions, which are then transformed into goals for a rhetorical problem solving process. There is some evidence that skilled writers use this model, and that it accounts for learning during writing in at least some instances (Bereiter & Scardamalia, 1987; Klein, Boman & Prince, 2007).

The present study was initially conceptualized in terms of the knowledge transforming model. Fifth grade students were presented with a newspaper clipping reporting the disappearance of fish from a river. They received source materials containing relatively raw information, and worked with partners to write an explanation of the disappearance. The source documents implicitly supported an explanation in terms of episodic acidification, a phenomenon in which the acidity of a body of water briefly rises markedly. All nine groups created a partial or nearly complete explanation. However, neither the knowledge transforming model nor other models of writing based on expert strategies provided a framework that fit the students' discourse and text; the writers individually engaged in almost no pre-writing text planning or process planning, little explicit means-end problem solving, and little post-writing revision. Instead, the collaboration of the writers, and their interaction with an assignment and sources rich in structured information, appeared to allow them to construct explanatory texts.

It will be proposed that four aspects of the students' writing were situated, emergent, or distributed: First, the students' task representation appeared to be situated, apparently arising from the interaction between the students' prior knowledge of the mystery genre, and the narrative frame in which the task was presented. Second, the writing process appeared to emerge from the dialogue between the writers: Each writer's comments, taken individually, would comprise a simple strategy; however, taken jointly, they instantiated a more complex process in which they regulated the writing process, and extended and