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The logogenesis of writing to learn: A systemic functional perspective

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ABSTRACT

Writing to learn has become an important practice in science education. How is scientific knowledge constructed during writing? To investigate this question, we examined the process through which four university students constructed written explanations of either projectile motion or buoyancy. The analysis, informed by systemic functional linguistics, focused on the mapping of semantic elements to grammatical choices, and the way in which this mapping unfolded throughout the course of each text. The texts began largely congruently; grammar mapped closely to experience. Gradually, each text shifted towards greater use of grammatical metaphor. Nominalization allowed propositions and sequences of events to serve as participants in complex causal and epistemic relationships. Students' texts showed several properties of professional scientific texts: transcategorization, compaction, and logicality; however, professional science texts instantiate these properties synoptically and systemically, whereas student texts exemplify them dynamically and instantially.

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1. Introduction

1.1. Writing to learn

Writing has long been considered a vehicle for thinking and learning (Donald, 2001; Galbraith, 2009; Goody & Watt, 1963; Oatley & Djikic, 2008; Ong, 1982). The effects of writing on learning have been of particular interest in education (Emig, 1977; Klein, 1999; Nückles, Hübner, & Renkl, 2009). "Writing to learn" refers to a set of educational practices in which students engage in a writing activity for the purpose of coming to better understand content or disciplinary modes of reasoning. Writing to learn takes a variety of forms (Klein & Yu, 2013). In one common type of activity, a student has an educational experience such as conducting a science experiment, and then writes a journal entry to interpret it (also called a "learning log" or "learning protocol;" e.g., Bangert-Drowns, Hurley, & Wilkinson, 2004; Drabick, Weisberg, Paul, & Bubier, 2007; Nückles et al., 2009). The purpose of the learning log is primarily to promote learning through reflective thinking; consistent with this, the principal readership is the writer himself or herself and the teacher. The writing is typically elicited through a brief though-provoking prompt; it is informal; it is typically completed in a single session resulting in a single draft of the text; it is typically completed individually; and it is about one page in length.

Previous research shows that writing usually contributes significantly to learning (Bangert-Drowns et al., 2004; Drabick et al., 2007; Klein, Piacente-Cimini, & Williams, 2007). Science education has been a particularly active venue for the

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Table 1
Semantic elements and corresponding grammatical class in congruent construal.

Semantic function	Construed by grammatical class
Relator (in sequence)	Conjunction
Minor process (in circumstance)	Preposition
Process	Verb
Quality	Adjective
Manner of process	Adverb
Entity (thing)	Noun
Figure (event)	Clause
Sequence of figures	Clause nexus

investigation of the role of writing in learning, with promising results (Bangert-Drowns et al., 2004; Gunel, Hand, & McDermott, 2009; Wallace, Hand, & Prain, 2004). However, the effects of writing on learning are variable: In some tasks, most students show evidence of learning, while in others they do not; and within tasks, individual students similarly differ in learning outcomes (e.g., Bangert-Drowns et al., 2004; Klein, 2004; Rivard, 2004). This variability invites the question, *how*, that is, through what process, do students use writing to learn? This paper addresses the question of process in terms of the way in which language functions to construe meaning. The time frame of interest in this paper is *logogenesis*, that is, the unfolding of meaning throughout a given piece of discourse, in this instance, a students' creation of a specific text (Halliday, 1998b, p. 88).

1.2. Systemic functional linguistic research on science text

Extensive research on the linguistics of scientific text has been carried out in systemic functional linguistics (hereafter, SFL; Banks, 2005; Halliday, 1997, 1998a, 1998b, 1999; Halliday & Matthiessen, 1999; Kopple, 2002; Martin, 2011). The logogenesis of scientific text has been contrasted with the construal of experience in informal speech (Halliday, 1998b; Martin, 2011). "Construal" refers to the way in which elements of experience or semantic elements (e.g., participants, processes, attributes) are mapped onto grammatical choices (e.g., nouns, verbs, adjectives). Everyday language is thought to map experience to grammar in a way that is relatively *congruent* (see Table 1). For example:

1a. The cart rolled quickly along the floor,
1b. and then it hit the wall.

The unit of experience in a congruent text is the event; semantically, this is referred to as a *figure*, which is realized congruently as a clause. The central element of a figure is a change in experience, or *process*, realized as verb, e.g., *rolled*. Persons or concrete objects comprise *participants* in these processes, congruently realized as nouns or pronouns, e.g., *cart*. Processes occur in some *circumstance*, frequently realized as a prepositional phrase, e.g., *along the floor*; and they may occur in some specified *manner*, frequently realized as an adverb, e.g., *quickly*. Two or more events comprise a *sequence*; these are connected by a *relator*, realized as conjunction (e.g., *and*) linking two clauses.

Consequently, congruent discourse presents a *dynamic* construal of experience, in the sense that each clause focuses on a change in experience. Congruent mapping is considered to be primary, in the sense that it is more characteristic of early childhood speech than later childhood speech (Painter, 1999); it is more characteristic of texts that students read and write in the earlier stages of education, than those that they write in the later stages of education (Christie & Derewianka, 2008); it is more characteristic of conversational speech than academic writing (Biber & Vásquez, 2008); and within the discipline of science, it is more characteristic of historically earlier texts than later texts (Kopple, 2002).

Professional scientific text reconstrues experience in ways that have been extensively documented in previous literature (Banks, 2005; Halliday, 1997, 1998a, 1998b, 1999; Halliday & Matthiessen, 1999; Kopple, 2002). A salient feature of scientific text is the extensive use of *grammatical metaphor*, in which a semantic element that would be construed congruently through one grammatical choice is reconstrued through a different grammatical choice. The most frequently discussed type of grammatical metaphor is nominalization, in which a process, which would congruently be construed as a verb, is instead construed as a noun, e.g., evaporate becomes *evaporation.* In a second common grammatical metaphor, an attribute, which would congruently be construed using an adjective, is instead construed using a noun, e.g., *long* is, e.g., *length*. In a third type, the relationship between two figures, which would congruently be expressed using a relator construed through a conjunction, is instead expressed as a process using a verb. For example, causation, which might congruently be expressed using the conjunction "so," is instead expressed using the verb "determines."

In scientific text, these features combine to form a common or "favorite" clause such as this one:

> *[Rapid changes in the rate of evolution]* <u>*are caused*</u> *[by external events].* (Halliday, 1998b, p. 59).

The Subject of this clause is a figure construed as a nominal group; it is followed by a semantic or logical relator construed as a verbal group; this is followed by a second figure construed as a nominal group.

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