Concepts and language: Developing knowledge in science

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ABSTRACT

This study of language and knowledge in the elementary science classroom was part of a larger three-year research project on teaching writing informed by systemic functional linguistics (SFL) theory (Halliday & Matthiessen, 2004). This article analyzes the experiential function of language and its impact on knowledge in the context of the science classroom. The teaching of a science integration specialist learning about systemic functional linguistics theory was analyzed throughout a unit on rocks and minerals. Student writing was analyzed for clause-level knowledge of content and language. Findings showed how the teacher engaged 5th grade students in learning content and language through discussions, creating models and writing. Findings also showed that throughout the unit students gradually developed language and content knowledge and the ability to express it in writing through clauses. Implications highlight the importance of understanding the functional role of language in learning science content.

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Introduction

"[L]anguage is the essential condition of knowing, the process by which experience becomes knowledge" (Halliday, 1993, p. 94). When people engage in new experiences they learn new concepts through the language associated with them. In school, many new concepts are learned across the curriculum each day. "Learning in school is done primarily through language, yet the language of school tasks is seldom explicitly discussed or taught in schools" (Schleppegrell, 2004, p. 19). This school-specific language has been referred to as the "hidden curriculum" (Christie, 1985 as cited in Schleppegrell, 2004). By not making such language explicit, schools are privileging those students with an awareness of the dominant culture or the culture of the school, and excluding others who either lack that cultural knowledge or are unfamiliar with those uses of language (Lemke, 1990; Schleppegrell, 2004).

One reason for the lack of explicitness regarding the language of school is that some teachers are not familiar with the linguistic aspects of the content they teach such as science, mathematics, social studies, and even language arts, and they therefore lack the tools necessary to teach students about language and its functions in these areas (Fillmore & Snow, 2000; Lemke, 1990; Schleppegrell, 2004; Snow, 2010). Teachers need to understand how language functions to build meaning in the content areas if they are to teach students to use domain-specific language to make meaning (Lemke, 1990). Systemic functional linguistics theory can help teachers gain this understanding (Schleppegrell, 2004).

The necessity of teaching language is true for elementary generalists and specialists alike (Christie & Derewianka, 2008; Fillmore & Snow, 2000; Halliday & Martin, 1993; Lemke, 1990; Schleppegrell, 2004). In the teaching of science, a paradigm shift must occur that embraces "strategic language activity, critical thought, and social relevance at the core of science

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learning" if science literacy is to be recognized as a key feature in the construction of scientific knowledge (Yore et al., 2004, p. 347). When teachers understand how "[l]anguage is a means of doing science and of constructing science understandings" (Yore et al., 2004, p. 348), they can teach students to build knowledge through language using a functional understanding of language (Halliday & Martin, 1993; Halliday & Matthiessen, 2004). This view of language can empower students and help them to succeed in school and beyond because it goes beyond the rule-based traditional grammar to view "language as a resource, a meaning-making system through which we interactively shape and interpret our world and ourselves" (Derewianka & Jones, 2012, p. 9). Understanding language as a meaning making tool is essential because "the ability to see how language shapes our construction of the world and experience, our relationship with others and the packaging and organizing of our messages and meanings places teachers and students in a strong position to reflect critically on the language interactions they participate in, [and] the texts they read and they write" (Coffin, 2010, p. 3). However, in order to accomplish this, teachers need to have a strong grasp of language and how it is functional. For example, while being able to explain scientific concepts in everyday language is an important part of learning content, it is insufficient. Students must also be able to explain scientific concepts in appropriate technical language to show understanding of scientific ways of conceptualizing knowledge about the world around them (Lemke, 1990). "[L]earning new ways of using language is learning new ways of thinking. Learning content means learning the language that construes that content as students participate in new contexts of learning" (Schleppegrell, 2004, p. 18).

The goal of this study is to analyze the teaching practice in fifth grade science when instruction is informed by systemic functional linguistics (SFL) theory. The analysis will focus on the development of knowledge through language by examining how a teacher uses language while engaging students in discussions, creating models and writing, and how students' knowledge is revealed in their writing. SFL theory will be used to analyze the teacher's use of language to teach content and student learning of content and language in elementary school science to understand how meaning is made at the level of the clause through processes (verb groups), participants (noun groups) and circumstances (adverbials).

Theoretical framework

Systemic functional linguistics (SFL) is a theory of language which describes how people use language to make meaning (Halliday & Matthiessen, 2004). In order to make meaning, people are constantly making choices about the language they use to express themselves in both oral and written texts. SFL theory has the potential to help teachers and students become aware of the linguistic choices available to them when they are using language and to increase those resources leading to greater meaning making potential (Christie & Derewianka, 2008; Coffin, 2010; Droga & Humphrey, 2003; Schleppegrell, 2004). Language is used to create texts which are based in both the culture and the specific context of the situation in which they are used (Halliday & Matthiessen, 2004). For example, a text created in the context of English language teaching in North America would follow structures and patterns consistent with North American ways of communicating in English, called genres. Taking this example one step further, creating this same text in a science class would entail understanding both the culture of North American English and also the culture of the domain of science. The context of the situation would be that of the classroom and the particular unit being taught.

According to Halliday and Matthiessen (2004), creating texts involves making language choices in order to convey the author's intended meaning (Fig. 1). On a theoretical level, these language choices depend on three metafunctions of language called the ideational function, the interpersonal function and the textual function (Halliday & Matthiessen, 2004, pp. 29–30). On a more practical level, the ideational function enables people to use language in specific contexts to share experiences, the interpersonal enables us to interact with others, and the textual supports us as we combine the first two functions to make coherent oral or written texts.

The ideational metafunction

It is primarily through the notion of the ideational metafunction that experience is expressed through language and knowledge is created (Halliday & Matthiessen, 2004). The ideational metafunction can be further divided into the logical and experiential metafunctions. The logical concerns relationships between clauses and how language is used to create logical connections among various elements of a text to create a coherent whole. The experiential concerns how language represents experience of the world at the level of the clause. The experiential metafunction is the focus of this paper.

Within the experiential metafunction, each clause is constructed around a process or event (Halliday & Matthiessen, 2004). Clauses can be expanded by adding various combinations of processes, participants and, in some cases, circumstances. Processes and participants constitute "the **experiential centre** of the clause. Circumstances augment this in some way. . . but their status in the configuration is more peripheral and unlike participants they are not directly involved in the process" (Halliday & Matthiessen, 2004, p. 176; emphasis in original). It is important to note that processes, participants and circumstances are not simply verbs, nouns and adverbs, but that they are verb groups, noun groups and adverbial groups, and each one can consist of a single word or several words working together to create more nuanced meaning. When used together to form clauses, these participants, processes and circumstances constitute the lexico-grammar of the language; the words and the grammar realize the meaning. Language is "fundamentally a tool for thinking with, a meaning-making resource (as opposed to, for example, a set of rules)" (Coffin, 2010, p. 2).