

Introductory geology: Is there a common language?

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INTRODUCTION

Geologic terms provide a common language for communicating geoscience concepts. Because introductory geoscience students can learn only a limited number of these terms, questions arise about which terms are essential to learn and if there is agreement between geoscientists on these terms.

Students are frequently exposed to terms through their textbooks, and previous studies have examined vocabulary in texts, although not college-level geology textbooks. In a high school earth science textbook, Groves (1995) found a rate of 4.45 scientific terms per page. Zechmeister and Zechmeister (2000) compared ten college-level introductory psychology textbooks and counted 2,505 unique terms in the glossaries, with <3% of terms common to all ten glossaries.

An extensive use of geologic terms in introductory textbooks may lead to difficulties in learning. The limited working-memory capacity of most novices results in the ability to attend to only a small amount of new information while reading, which decreases text comprehension (Sweller et al., 1998; Cain et al., 2004). If students are using their mental capabilities to comprehend unknown terms, their cognitive systems could become overloaded, and deep cognitive processing may not happen. Students may use geologic terms without fully understanding their underlying concepts (Libarkin and Kurdziel, 2006; Kortz and Murray, 2009; Clark et al., 2011). In addition, students have less facility than experts in extracting the relevant information and seeing the big picture (e.g., Caillies et al., 2002; Patrick et al., 2005). Therefore, students may focus on small details, such as geologic terms, instead of using those terms to construct a holistic conceptual understanding. Students may then have an illusion of deep understanding because they can recognize vocabulary words (Graesser and Forsyth, 2013).

Extensively incorporating terms may lead to unintended consequences. For example, an emphasis on learning terms may contribute to the misconception that science is a finished body of knowledge requiring abundant memorization (Groves, 1995). In addition, introducing large numbers of terms may lead to the emphasis on a breadth instead of a depth of knowledge, contrary to what has been recommended by education reformers

(Bransford et al., 2000; Earth Science Literacy Initiative, 2009; Next Generation Science Standards, 2014).

Since the copious use of terminology potentially affects student learning, and limiting terminology requires knowing which terms are most valued by geologists, we analyzed terms in college-level introductory geology textbooks. In particular, we analyzed glossary terms, comparing whether a common vocabulary exists between the textbooks.

METHODS

We tabulated glossary terms in 16 introductory physical geology textbooks. Minor variations in terms (e.g., “P-wave” and “P wave”) between textbooks were combined into a common term that was used during analysis. One author compiled terms, and the other author confirmed the list.

RESULTS

Textbooks written by the same authors (e.g., essentials and full versions) used a fairly consistent language, so we present the analysis of only the full versions of ten textbooks. We note, however, that one “essentials” textbook (Marshak, 2009) had more terms in the glossary (1,435) than the “full” version (1,301 terms; Marshak, 2008).

We identified 2,776 individual, unique terms in the ten full-version textbooks, averaging 678 terms per book glossary (Table 1). To verify that the glossary terms matched the bolded words in textbooks, we crosschecked 10% of the glossary words and bolded words in a subset of three textbooks and found that 96.8% of bolded words ($n = 210$) were in the glossary, and 93.6% of glossary terms ($n = 203$) were bolded. Italicized words increased the total number of words emphasized in the text by 1.5 times, although they were not included in our analysis because they were predominantly not in the glossary.

There was minimal overlap in glossary terms between the textbooks. Only 44 terms (1.6% of the unique terms) were common to all ten textbooks. Examples of these 44 terms are abrasion, barrier island, epicenter, igneous rock, joint, mantle, plate tectonics, and volcano. Only 16.4% of terms are in five or more textbooks, and over half of terms (55.3%) were unique to individual textbooks. Examples of the 39.5% of terms unique to Marshak (2008) include dormant volcano, olistotrome, sabkah, snotite, and topsoil, whereas examples of the 8.5% of terms unique to Murck et al. (2010) include fractionation, kingdom, and seismic discontinuity. Unique terms may be used in other textbooks, but if they were not in the glossary, they were not included in this study.

Table 1. Number of glossary terms in full-version introductory geology textbooks and percentage of those terms that are unique to each textbook.*

Textbook number*	1	2	3	4	5	6	7	8	9	10
Number of glossary terms	1301	976	884	762	578	519	519	494	486	259
Percent unique to the textbook	39.5	29.6	20.5	14.0	17.1	14.1	12.1	26.3	11.5	8.5

*The sum of terms across the 10 books is 6,778, with 2,776 unique terms.

*1—Marshak (2008); 2—Reynolds et al. (2010); 3—Plummer et al. (2011); 4—Tarbuck and Lutgens (2008); 5—Grotzinger and Jordan (2010); 6—Smith and Pun (2010); 7—Chernicoff and Whitney (2007); 8—Fletcher (2011); 9—Monroe et al. (2007); 10—Murck et al. (2010).

DISCUSSION

This study presents a lower limit on the vocabulary necessary for students to understand textbooks, because italicized and non-technical terms with specific geologic implications were not included. Consider this example: “Whenever *slabs* of continental *lithosphere* and *oceanic lithosphere* converge, the *continental plate* being less *dense* remains ‘*floating*’ while the *denser oceanic lithosphere* sinks into the *asthenosphere*” (Lutgens et al., 2012, p. 31, italics added). This sentence illustrates the potentially overwhelming amount of scientific terminology from which students must extract deeper meaning, which may not happen if they are focused on the terms (Graesser and Forsyth, 2013).

Our findings raise questions about the purpose of introductory textbooks (Bierman et al., 2006). If they are intended to be used as reference books, then extensive glossaries are appropriate. However, if their purpose is to serve as a means for students to deeply learn fundamental concepts, then large glossaries, as identified in this study, likely overwhelm that goal. Can there be a happy medium?

This study lays the groundwork for future work. The minimal overlap between the textbooks studied suggests that the common language of geology is not defined at an introductory level. We would argue that not all of the 44 overlapping terms, such as abrasion and joint, are necessarily essential for students to know, and we hope to start a discussion about which terms (and relatedly, which concepts) should be covered in an introductory course. In addition, because there is necessary jargon, we hope to further the discussion about optimal ways to introduce students to it.

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