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The effects of reading to prepare for argumentative discussion on cognitive engagement and conceptual growth

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ABSTRACT

Dialogue based approaches to education have been shown to benefit students through the quality of shared discourse. Warm conceptual change theories propose that these benefits are also mediated by increasing student engagement. Discourse and engagement effects were isolated in this study by having 130 third and fourth grade students read a science text for different purposes (no stated purpose, to prepare for a regular classroom discussion, or to prepare for an argumentative discussion) and then testing children before the discussion took place. Children who anticipated a discussion, especially an argumentative discussion, read more slowly than other children after controlling for fluency. A subset of reading times predicted conceptual growth. Finally some children who participated in argumentative discussions had higher rates of conceptual growth. Results substantiate the efficacy of argumentative discussion as a context for reading scientific texts, and they support the central mechanism of dual-processing theories of warm conceptual change.

1. Introduction

Research over three decades has established social interaction as a powerful pedagogic tool in the science classroom (Bennett, Hogarth, Lubben, Campbell, & Robinson, 2010; Hofstein & Lunetta, 2004; Lemke, 1990; Solomon, 1993). In particular, argumentative discussion has been shown to be an effective method (Driver, Newton, & Osborne, 2000; Jiménez-Aleixandre, Rodríguez, & Duschl, 2000; Kuhn, 1993; Osborne, 2010; Pontecorvo, 1987; Zohar & Nemet, 2002). Jimenez-Aleixandre and Erduran (2008) gave the following list as a summary of the ways that argumentative discourse improves science education outcomes: helps students use the cognitive processes of scientists, develops critical thinking, teaches the discourse of science, communicates the culture of science, improves reasoning about scientific topics, and leads to better understanding of the nature of science. All of these effects of argumentative discussion are valuable, but the list focuses solely on the cognitive benefits of exchanging words in an argumentative discourse and not on the affective and motivational impacts of these social interactions. Anyone invigorated by a good discussion can sense that social approaches can change the way people feel and think above and beyond the words that are exchanged. The affective and motivational aspects of discussion are rarely studied despite their potentially important practical implications. In a review of 94 studies of small group discussion in science classrooms, Bennett et al., (2010) found no research focused on affective or motivational consequences.

Of the many attitudinal and motivational constructs that might be enhanced by discussion and reading for discussion, engagement is perhaps the best suited to the study of the effects of discussion, because it is situational rather than trait oriented. Fredricks, Blumenfeld, and Paris (2004) describe engagement as a multifaceted construct consisting of three interconnected aspects: behavioral engagement which includes students actively participating in learning activities, emotional engagement which includes having positive feelings about learning activities, and cognitive engagement which includes "the willingness to exert the effort necessary to comprehend complex ideas and master difficult skills" (p. 60)

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encountered during activities. All three of these types of engagement interact and are likely affected by school activities.

The study of the connections between, engagement, science learning, and social interactions such as argumentative discourse can be explained in terms of a theoretical perspective known as *warm conceptual change*. The field of conceptual change developed to address the repeated observation that students' non-scientific preconceptions about the natural world are not easily changed (Duit & Treagust, 2003). The original theories of conceptual change foregrounded cognitive processes needed to make sense of scientific principles and relegated motivational, affective and social factors to the role of minor moderating variables (Pintrich, Marx, & Boyle, 1993). The explanatory and pedagogic shortcomings of the original theories led to new theories termed 'warm' because they gave motivational, affective, and social variables a central role (Abd-El-Khalick & Akerson, 2004; Cobern, 1996; Linnenbrink & Pintrich, 2002; Pintrich et al., 1993; Sinatra, 2005).

1.1. Persuasion based theories of warm conceptual change

Some of the warm conceptual change theories are directly influenced by theories of persuasion developed in the fields of social psychology and communications (Dole & Sinatra, 1998; Gregoire, 2003; Mason, 2001; Murphy, 2007; Woods & Murphy, 2001). There is a natural resonance between persuasion and warm conceptual change research, because both address the often emotionally-laden phenomenon of people changing their minds – often requiring them to abandon well-entrenched beliefs.

One prominent persuasion based conceptual change theory is the Cognitive Reconstruction of Knowledge Model (CRKM) developed by Dole and Sinatra (1998). The CRKM and other similar theories make use of the dual-process theory of persuasion known as the Elaboration Likelihood Model (ELM, Petty & Cacioppo, 1986) as well as the classic conceptual change model (CCM, Posner, Strike, Hewson, & Gertzog, 1982).

The Elaboration Likelihood Model (Petty & Cacioppo, 1986) theorizes that when a person receives a message, but before much substantive information has been acquired, the person must choose (consciously or without awareness) how deeply to process that message (Craik & Lockhart, 1972). While people generally want to understand the world and to hold accurate beliefs, they are also reluctant to expend cognitive effort unnecessarily. The tension between these two desires determines the depth of processing (similar to other theories of setting standards of coherence in reading; see van den Broek, Lorch, Linderholm, & Gustafson, 2001). The ELM is called a dual-process theory, because the extremes of processing imply qualitatively different cognitive strategies. Relatively shallow "peripheral" processing includes quick cognitive strategies such as counting the number of arguments. Relatively deep "central" processing includes cognitively intensive strategies such as analyzing the logic of arguments. While attitude change is possible through either route, change through the central route will be stronger and more persistent over time because it results from more elaborate strategies (Petty, Rucker, Bizer, & Cacioppo, 2004).

In constructing the CRKM, Dole and Sinatra (1998) tried to preserve the best features of both the ELM and classical theories of conceptual change. The CRKM has a dual-processing structure similar to the ELM. The theory reflects earlier ideas about conceptual change with the addition of key personality and motivational constructs including social context. One important difference between the ELM and the CRKM is that the central mechanism is depth of engagement rather than depth of processing. In particular the CRKM focuses on the cognitive form of engagement. In addition, the structure of the CRKM is explicitly described as an iterative process in which there is a continuous flow of receiving information, engagement and processing. The CRKM does not claim to be exhaustive and is still being developed through empirical study.

Early studies that invoked the CRKM tended to be exploratory instructional intervention studies (Alexander, Fives, Buehl, & Mulhern, 2002; Nussbaum & Sinatra, 2003). More recently researchers have probed specific predictions of the theory. Some of these studies have examined the interplay between several warm variables over large and intermediate instructional time scales. These researchers have either not needed to gather direct measurements of engagement (Broughton, Sinatra, & Nussbaum, 2011; Lombardi, Sinatra, & Nussbaum, 2013; Taasoobshirazi & Sinatra; 2011) or have used off line measures such as self-report (Hynd, 2003; Johnson & Sinatra, 2013). Other researchers have concentrated on the moment-by-moment effects of individual variables on engagement over short time scales. For example, Ranellucci et al. (2012) used think-aloud protocols while students read two short refutational reading passages to explore the interplay of student's goal orientation, depth of processing and conceptual change.

1.2. The current study

The present study employs the CRKM as a theoretical framework for exploring the effects of discussion and particularly argumentative discussion on students' cognitive engagement while reading a science text. Researching this aspect of discussion poses a series of difficult methodological hurdles. First and foremost, it is difficult to isolate the effects of the words exchanged during discussion from the effects of engagement. However, it is possible to infer what the effects of cognitive engagement in discussion might be by testing the effects of the mere anticipation of discussion. This would be an important result in itself, and it would suggest that students increased engagement preparing for a discussion might continue throughout the lesson.

A second methodological problem is that engagement is a difficult construct to measure because it is multifaceted and can be observed at different time scales (Sinatra & Heddy, 2013). Since this study focuses on the anticipation of a discussion, which is likely a subtle and short-lived phenomenon, it uses sensitive measurement and frequent sampling. In addition, the study simplifies measurement by focusing on one aspect of engagement – cognitive engagement. While it is only one aspect of engagement, it is the one most closely associated with dual-processing models and their effect on conceptual change.

1.2.1. Manipulating anticipation of a future discussion

In this study, the anticipation of a future discussion is hypothesized to impact a student's purpose for reading. Reading to prepare for a discussion is a method of increasing cognitive engagement that dates back to early research in persuasion (Chaiken, 1980). Reading for the purpose of discussion is likely to change the experience of reading in a number of ways including changing the feeling of accountability to peer judgment (Johnson & Eagly, 1989). One problem with instructing students to read for the purpose of preparing for a discussion in the context of classrooms rather than a laboratory context is that classrooms have very different forms of discussion.

Researchers studying classroom discourse have observed that some classrooms have a format for discussion during which the teacher does the majority of talking, controls the content, and has evaluative authority (Cazden, 2001; Lemke, 1990; Mehan, 1979). Anticipating this type of discussion might have small effects, because students know they will rarely speak and are chiefly accountable to the teacher to answer questions of limited scope.