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Inspiring integration in college students reading multiple biology texts

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ABSTRACT

College students often struggle when they are faced with situations where they are required to read multiple texts and integrate across them. The present study examines an integration task designed to stimulate cross-system integration for college biology students reading about two related physiological systems. Learners (n = 617) were randomly assigned to read about the endocrine and urinary systems in the form of either two separate texts or a single text as they completed one of three task conditions: an integration condition, a comprehension condition, or a comparison condition. After reading, learners completed a free recall test and these responses were scored for whether or not learners integrated between the two physiological systems. Findings revealed that learners who engaged in the condition designed to stimulate integration were statistically significantly more likely to have integrated than those in the two comparison conditions. In addition, learners who read about the systems in the format of a single text were statistically significantly more likely to integrate than those who read the texts separately. Learners' self-reported strategy use was also examined. Learners' integration strategy use mediated the impact of the integration condition on the integration outcome measure. In sum, there is evidence that the integration condition employed in this study is a promising avenue for supporting college students' reading of multiple, componential texts.

1. Introduction

Undergraduate students often face situations that require reading and integrating across multiple texts, including reading to evaluate a controversial issue (Anmarkrud, Mccrudden, Bråten, & Strømsø, 2013; Bråten, Anmarkrud, Brandmo, & Strømsø, 2014), to learn about historical events (Cameron, Van Meter, & Long, 2017; Wiley & Voss, 1996), and to prepare for an exam (Strømsø, Bråten, & Samuelstuen, 2003). Although these situations all require comprehension of each individual text, the reader must also generate cross-text inferences to integrate across the texts and obtain a complete understanding (Rouet & Britt, 2011; Van Meter & Firetto, 2008). The reader who constructs an internal representation that includes these connections will have more complete knowledge than can be gained from any one of the texts alone (Perfetti, Rouet, & Britt, 1999).

Several factors can influence readers' cross-text inference generation. One such factor is the task that the learner is reading to complete. Multiple-text reading can be affected by a variety of tasks including writing either argumentation essays (Wiley & Voss, 1996) or text summaries (Britt & Sommer, 2004, Exp. 1). Another factor pertains to the relationships between multiple-text reading and individual difference variables such as strategy use (Kobayashi, 2009) and source selection (List, Grossnickle, & Alexander, 2016). While much has been learned about the factors that affect multiple-text reading, significant questions remain. With respect to tasks, for instance, current evidence indicates that tasks can support multiple-text reading, but it remains unclear which tasks are most effective. In addition, the significant majority of research on multiple-text reading has focused on conflicting-view texts, that is, texts that present information inconsistent with, or contradictory to, other texts within the set (e.g., Murphy et al., 2016; Stadtler, Scharrer, Macedo-Rouet, Rouet, & Bromme, 2016; Wolfe & Goldman, 2005). Yet, in practice learners also face tasks requiring integration across texts that share a componential relationship, where each text contributes unique information and fits with information from the other texts in the set (Bråten et al., 2014). An example of multiple, componential text reading is the college biology student who reads separate texts about different physiological systems in the human body and must connect across these systems to gain a complete understanding of how the human body functions as a whole.

The present study contributes to the research on multiple-text reading by examining both of these issues. Learners were college biology students who read two componentially-related texts. Experimental conditions tested the effects of a task, which was designed to support readers' generation of cross-text inferences. A measure of

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readers' within- and between-systems comprehension strategies was also included to test the hypothesis that a task could improve multiple-text reading when that task stimulated readers' use of text integration strategies.

1.1. Learning from multiple texts

Multiple-text reading refers to reading in which separate texts each provide some part of the information to be gained but no single text includes all of the information. In academic domains, multiple-text reading is most commonly examined in the context of history where different authentic documents each provide different perspectives and conflicting accounts of a historical event (e.g., Wineburg, 1991). However, multiple-text reading is also studied in situations where learners must gather information across texts when reading about a socio-political issue (Strømsø, Bråten, & Britt, 2010), evaluating scientific controversies (Stadtler et al., 2016), or deepening content area knowledge (Strømsø et al., 2003).

1.1.1. Theoretical framework

The theoretical foundation of multiple-text reading is built upon Kintsch's (1988) Construction-Integration (CI) model of text comprehension. The CI model describes text comprehension as occurring through both construction and integration processes. During *construction*, words on a page are formed into propositions, which are then connected to other propositions through element overlap. These propositions create a network, and new propositions are incorporated into this network through *integration*. A mental representation of the text is formed through a series of iterative cycles between these two processes (Kintsch, 1988). While bottom-up processes act to “constrain” comprehension, top-down processes act to “guide comprehension” (Kintsch, 2005, p. 125). Thus, both the context in which learners read and learners' strategic processes have an impact on the construction of the knowledge representation.

Three different types, or levels, of internal representations of the text can be generated from these processes. Both the surface and text-base levels adhere closely to the content provided in the text. A situation model, by contrast, is constructed by the reader who generates inferences to connect across the text and between the text and prior knowledge (Van Dijk & Kintsch, 1983). In the context of multiple-text reading, however, a single situation model may not always be sufficient (Perfetti et al., 1999). Britt and colleagues (Britt, Perfetti, Sandak, & Rouet, 1999) have forwarded four potential situation models of how learners might represent the content learned from multiple texts. The *separate representation model* illustrates an understanding of the content where independent situation models are derived from each text. Information from each text is well connected in each of the situation models, but connections between the texts are non-existent. Conversely, the *mush model* presents a singular situation model with robust connections between relevant information across the multiple texts. A defining feature of both the separate representation model and the mush model is the lack of source tagging (i.e., the association of pieces of knowledge with respect to the source it was derived from). As a result, Britt and colleges describe both of these models as “less than optimal” (p. 219) and argue for the importance of constructing situation models that include source tagging (e.g., *tag-all model* and, in particular, the *documents model*).

It is important to note that the documents model was derived from the domain of history (Britt et al., 1999), and history is a domain characterized by texts containing conflicting information. In other domains, notably biology, texts may be componential in nature. Further, source information is not always available to the reader or it may not differ between the texts being read. Returning to the earlier example of the college biology student, this learner may read multiple texts about each of the physiological systems in the human body all from the same textbook over a period of several months. The ideal situation model would most certainly include numerous connections across these systems (e.g., a mush model) and texts, rather than separate representation models for each of the systems or texts. However, it is unclear what the added value of source tagging would be, given that all tags refer back to the same textbook.

More recently, researchers have attempted to understand more about the factors that guide learners to develop these integrated representations across multiple texts. Building on the aforementioned research, Rouet and Britt (2011) have forwarded the Multiple Documents-Task Based Relevance and Content Extraction (MD-TRACE) model. In MD-TRACE, like Kintsch's CI model, both bottom-up and top-down processes guide the learners' construction of information from multiple texts (Rouet & Britt, 2011). Specific reading conditions, such as the texts learners are reading or the task the learner is working on, are expected to exert a direct effect on how the learner reads multiple texts. These conditions are also expected to interact with readers' internal factors such as strategy use. Finally, like the reading of single texts, construction can be influenced by both the texts, the reader's task, and the strategies that reader applies.

1.1.2. Multiple-text reading research

The research on multiple-text reading shows that many readers struggle with the demands of multiple texts. In Wineburg's (1991) seminal work, for example, novice history students were less able to apply historical thinking heuristics to build knowledge from a set of documents than were expert historians. Likewise, college students do not sufficiently execute the strategies that support connections across course resources when studying to learn course content (Strømsø et al., 2003). Still, more research has demonstrated that many college students only use a limited set of available resources when reading to answer a provided question (List et al., 2016) and multiple-text reading is impacted by topic-related beliefs (McCrudden & Sparks, 2014).

At least two conclusions can be drawn from the research on multiple-text reading. First, multiple-text reading can be positively influenced by the task the learner is assigned to complete (e.g., Cerdán & Vidal-Abarca, 2008; Gil, Bråten, Vidal-Abarca, & Strømsø, 2010; List et al., 2016). Britt and Sommer (2004) demonstrated this effect in two experiments with college students reading two conflicting-view texts. In Experiment 1, learners in the experimental task condition wrote a summary of the first text before reading the second text. Experiment 2 tested the effects of questions that drew learners' attention to either the micro- or macro-structure of the text. Learners in two experimental conditions answered one of the two types of structure questions for the first text before reading the second text. The two experiments showed task effects on the integration of the two texts; summary writing and macro-structure questions both lead to students' higher performance on posttest measures of text integration. Positive effects on multiple-text reading have also been found for other tasks including argumentation essays (Wiley & Voss, 1996), relation finding (Kobayashi, 2009), and self-questioning (Cameron et al., 2017).

A second conclusion emerging from the research is that multiple-text reading is affected by the learners' employed strategies (Afflerbach & Cho, 2009; Strømsø et al., 2003). Bråten and Strømsø (2011) illustrated this with college students who self-reported strategy use while reading seven conflicting-view texts. Strategy use was measured by the Multiple-Text Strategy Inventory (MTSI), an instrument assessing both fact accumulation and cross-text elaboration strategies. Relationships between readers' strategy use and scores on a cross-text integration posttest were found for learners who read the texts without any experimental intervention. Learners who reported a high level of accumulation strategies had lower integration posttest scores, but those who reported high levels of cross-text elaboration strategies had higher scores on the integration measure. Research by Kobayashi (2009) extends these findings by showing not only that strategies affect learning from multiple conflicting-view texts but also that tasks influence this effect. College students read six conflicting-view texts. In two