Integrating Social and Psychological Perspectives on Writing as a Learning Activity

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Abstract

Both the psychological perspective and the social perspective on writing have been demonstrably successful theoretically, empirically, and pedagogically. The goal of this paper is to show that these two perspectives on writing as a learning activity are not only complementary, but each requires the other for full intelligibility. How can these two perspectives be connected in order to understand writing to learn? It is argued that writing is specifically a technology for amplifying the power of natural language to integrate cognitive representations and processes across individuals. Social and cognitive processes play a role in WTL on historical, ontogenetic, and microgenetic time scales. Theories that integrate these two perspectives, including genre as social action, Vygotskian sociocultural theory, and distributed cognition are applicable to writing as a learning process. Recent programs of research on writing to learn have frequently been conceptualized in cognitive terms; however, they also illustrate social processes, particularly the emergence of new subgenres. Composing in the New Literacies includes practices that are collaborative, digital, and multimodal. These practices can be unpacked into an interplay of cognitive and social processes, which contribute to learning during composition.

Keywords: social processes, cognitive processes, writing to learn, new literacies

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Resumen

Tanto la perspectiva psicológica como la social sobre la escritura han sido exitosas teórica, empírica y pedagógicamente. El objetivo de este documento es mostrar que estas dos perspectivas sobre la escritura y sobre la actividad de aprendizaje no solo son complementarias, sino interdependientes para su total comprensión. ¿Cómo se pueden conectar estos dos enfoques de manera que permitan entender la escritura para aprender? Se argumenta que la escritura es específicamente una tecnología para ampliar el poder del lenguaje natural con el fin de integrar entre los individuos representaciones cognitivas y procesos. Los procesos sociales y cognitivos desempeñan un papel en WTL en escalas de tiempo históricas, ontogenéticas y microgenéticas. Las teorías que integran estas dos perspectivas, incluido el género como acción social, la teoría sociocultural de Vygotsky y la cognición distribuida, son aplicables a la escritura como un proceso de aprendizaje. Los recientes programas de investigación sobre la escritura para aprender se han conceptualizado con frecuencia en términos cognitivos; sin embargo, también ilustran procesos sociales, particularmente, con la aparición de nuevos subgéneros. La producción escrita, en las nuevas alfabetizaciones, incluye prácticas que son colaborativas, digitales y multimodales. Estas prácticas se pueden desagregar en una interacción de procesos cognitivos y sociales, que contribuyen al aprendizaje durante dicha producción.

Palabras clave: procesos sociales, procesos cognitivos, escribir para aprender, nuevas alfabetizaciones

Introduction

Writing as a learning activity, or *writing to learn*, is the use of written composition to support students in thinking and learning about subject matter. During the past four decades, research on WTL has been conducted in a variety of subjects, including science, history, literature, mathematics and the professions, with learners from elementary school through university (Bangert-Drowns, Hurley & Wilkinson, 2004; Lewis & Ferretti, 2011; MacArthur, 2014). The past fifteen years have seen tremendous progress in research on writing as a learning activity (Graham & Hebert, 2011; Klein & Boscolo, 2016).

The theoretical framework for most of this research has been cognitive. Cognitive research has been rigorous in its methods, providing reliable answers to the question of whether writing contributes to learning (Bangert-Drowns *et al*., 2004; Hebert, Gillespie & Graham, 2013; Klein &

Boscolo, 2016). Cognitive research has also identified several kinds of processes that contribute to learning during writing (Klein, Piacente-Cimini & Williams, 2007; Roelle, Krüger, Jansen & Berthold, 2012), as well as several kinds of writing activities that contribute to learning (Galbraith, Ford, Walker & Ford, 2005; Glogger, Schwonke, Holzäpfel, Nückles & Renkl, 2012; Martínez, Mateos Sanz, Martín & Rijlaarsdam, 2015).

At the same time, socially oriented research has made important contributions to knowledge about writing. Social researchers have maintained a consistent focus on writing as it is actually practiced in schools, as well as in work and leisure settings. This approach has also provided theories of broad scope that recognize the historical and cultural context of writing. This has included work on the role played by writing in the history of knowledge societies and the emergence of academic disciplines (Bazerman & Rogers, 2008; Starke-Meyerring & Pare, 2011). Additionally, social research has directed attention to issues of power, equity, and identity in literacy (Christensen, 1999; Kostouli, 2009).

To date, most research on writing to learn has been based on specific kinds of writing activities: these have involved individual writing; the medium has often been pen and ink, or sometimes electronic text, and the modality has been limited to text alone. Conversely, socially-oriented research has been closely attuned to the changing nature of writing (Bezemer & Kress, 2016; Coiro, Knobel, Lankshear & Leu, 2014; Cope & Kalantzis, 2015; Russell, 2013a, 2013b; Unsworth, 2011). Writing has become increasingly digital; even in elementary school, many writers have access to an ocean of resources on the Internet, and they frequently compose texts that are electronic (e.g., Mills & Exley, 2014). Writing is frequently collaborative, and this collaboration often occurs through digital media (Hakkarainen, 2009; Petko, Egger & Graber, 2014; Wecker & Fischer, 2014). And writing, or more broadly, *composing*, is increasingly multimodal, with students integrating a variety of kinds of representations, including graphical and audiovisual media (Bower, 2015; Cope & Kalantzis, 2015).

Given the significant contributions of both the cognitive and social perspectives, it is important to consider how to integrate the two. This chapter will discuss such integration, with a focus on three questions:

- First, how can we theorize the integration of cognitive and social perspectives on writing to learn?

- Second, what does recent research on writing to learn, which is largely cognitive, show us about the social aspects of writing to learn?
- Third, what does the emerging research on the New Literacies suggest how social and cognitive processes are integrated in recent practices in writing to learn?

Theoretical Approach

To consider how writing supports learning in a way that integrates cognitive and social perspectives, I want to suggest a provisional conception of writing: *Writing is a symbolic technology, the purpose of which is to coordinate human action by distributing cognition, by distributing language across space and time.* The argument for writing as social action has been elaborated most extensively concerning genre (Bazerman, 2012; Miller, 1984, 2015). On this theory, genre provides a repertoire of ways of construing situations, goals, possible actions, roles and forms of discourse that allows humans to act together. However, I want to point out that writing coordinates human action in a specific way: By distributing cognition. That is, writing allows networks of agents to express cognitive states and processes, evoke states in others, collect their results, and share these results among collaborators. This cognitive aspect is apparent in a close reading of the theory of writing as social action, which refers to "construing" situations, goals, etc. Examples of the complex processes through which writing mediates human thought and joint action are abundant in the literature on writing in the workplace (Angeli, 2015; Beaufort, 2008; Haas & Witte, 2001; Swarts, 2016).

To conceptualize the way in which cognitive and social processes act together and affect one another, I want to elaborate on these relationships across three-time scales, as outlined in cultural-historical theory (Cole & Engeström, 1997; Engeström, 2009; Prior, 2012; Wertsch, 1986). The first-time scale is historical, the time scale during which genres emerge. In the history of genre, we can see the interplay between social forces and cognitive abilities. Larger social entities, such as economic systems, institutions, and ideologies, create exigencies that set the stage for typified rhetorical situations which comprise genres. These genres then involve resources for shaping the cognitive acts of writers. Among the things that people learn when they learn a genre, are ways of construing situations, goals, and forms of discourse; genres also include beliefs about knowledge, and modes of reasoning or argumentation (Bazerman,

2012; Miller, 1984; 2015). Conversely, cognitive abilities shape genres (that is, social practices) on the historical timescale; examples are discussed below.

The second time scale is ontogenetic, the timescale of individual development, including learning (Cole & Engeström, 1997). On the ontogenetic scale, students develop writing skills and learn genres that they can enact to support learning during writing. A key process that integrates the social and the cognitive is internalization. During ontogeny, a genre, which is a form of social action, can be partially internalized in the way of a cognitive scheme that represents aspects of the genre and guides writing (Olinghouse & Graham, 2009). Conversely, the child's cognitive capacities, structures, and processes enable and constrain the learning of genre. These include the child's theory of mind—the understanding of other people and their mental states; prior knowledge concerning both text structure and topic knowledge; and working memory capacity—the mental space in which ideas and language are operated on (Kim & Schatschneider, 2017). Some empirical evidence has demonstrated interactions between elements of genre instruction and prior knowledge, which affect both writing and learning during writing (Klein & Ehrhardt, 2015; Klein & Haug, 2016).

The third time scale, "microgenetic," refers to the unfolding of the episode of writing from moment to moment. As a theoretical framework for considering this framework, I will refer mainly to distributed cognition (Hutchins, 1995; Klein & Leacock, 2012; Newell, 2006). Distributed cognition takes a dual perspective on complex human activities. One perspective is centred on the individual; cognitive processes are dependent on individual agency, but these processes are supported and modified using external artifacts, as well as "inputs" from and "outputs to" other people. External artifacts support cognition in a variety of ways, such as providing information, supporting working memory operations, guiding action, and externalizing ideas (Hutchins 1995, 2014; Rivers, 2011; Zhang & Patel, 2006).

At the same time, distributed cognition takes a second perspective on complex human activities, which views them as emergent: These activities are distributed across people and external artifacts. This emergent process can be different from the cognitive process of any one participant; that is, there are cases in which no one individual holds all the knowledge or executes all the cognitive processes, involved in the activity. An analysis of a system from a distributed viewpoint would identify the elements of the system, the processes through which they interact, the way in which they become coordinated with one another, and the representations that are created and transformed

in the course of this interaction. These activities are coordinated according to cultural practices—for example, genres of writing (Cronin, 2004; Hutchins, 2014; Klein & Leacock, 2012; Newell, 2006; O'Hara, Taylor, Newman & Sellen, 2002; Slattery, 2007). Thus, a genre helps to invite, sequence, and gather up the products of the cognitive acts of everyone; and individual cognition enables and constrains the genre by providing the set of cognitive operations, which the social practice can organize.

From this point of view, current theories of writing point to one set of phenomena but do so under two ontologies. One ontology is comprised of mental constructs; the other ontology is comprised of social and material entities and processes. For example, genre can be represented by a writing schema in long-term memory, but it is also instantiated in a typified rhetorical situation. Topic knowledge can be conceptualized as a set of schemata in long-term memory—and it can also be comprised of the source texts on which a writer draws. The writer's current writing plan can be comprised of goals and subgoals in long-term working memory, but it can be also be instantiated as a set of mediating representations, such as marginal notes in source texts and an outline. Cognitive processes of writing, such as evaluating text, can be carried out internally by the primary writer—and they can also be carried out externally to the primary writer, for example, by an editor or teacher (Hayes, 2012; Hayes & Flower, 1980; Leijten, Van Waes, Schriver & Hayes, 2014). A critical point is that these distinctions need not be issues of contention between cognitive and social theories. Rather, within cognitive theories, particularly distributed cognition, it is common to refer to cognitive and social entities, which play parallel roles in the process of writing, somewhat interchangeably (see Klein & Leacock, 2012 for a review).

What connects these two ontologies is signs; both internal and external representations are symbolic or can be treated as symbol-like. According to classical cognitive psychology, cognition is comprised of the manipulation of physical symbols—in the brain or a computer. Cognition, on this view, consists of combining symbols to create expressions and using operations to transform these into new expressions (Simon, 1996). In distributed cognition, this perspective is turned partially inside out, so that symbols and symbol transformations are construed as largely external. Similarly, writing, and revision can be the creation and transformation of external strings of symbols, that is, sentences. This mutual reliance on signs allows cognition in the head and writing in the world to mesh. That is, ideas can be externalized as text, exchanged, revised, internalized again, and so forth, iteratively.

Writing is specifically a technology that assists in making cognition social, while making social interaction more richly cognitive. On the present analysis, therefore writing "works." This dual ontology also explains why genre has been variously approached as social action, text form, and cognitive schemata. It is all three at once, or rather it connects all three.

Mainstream Research on Writing to Learn: Cognitive but also Social

In this section, I will sketch two recent illustrative programs of research on writing to learn. These programs are based largely on writing as an individual activity, and the theoretical framework for these two approaches has been largely cognitive. However, at the same time, these activities can also be viewed through the lenses of genre as social action, sociocultural theory, and distributed cognition, foregrounding their social aspects.

Freiburg Model of Journal Writing/ Self-regulated Theory of WTL

Researchers, mostly from the University of Freiburg, have conducted the most systematic program of research on WTL to date (e.g., Berthold, Nückles & Renkl, 2007; Hübner, Nückles & Renkl, 2010; Nückles, Hübner & Renkl, 2009; Roelle *et al.*, 2012). They have focused on the genre of the "learning protocol," which is similar to the learning journal. These researchers theorize that learning depends on students' application of cognitive and metacognitive strategies during writing. In a typical study, students are initially presented with information in the form of a lecture, an audiovisual presentation, or an online tutorial. They then write a learning protocol to interpret this information. To support students' writing, they are provided with cognitive and metacognitive prompts. Cognitive prompts encourage students to make connections among elements of new knowledge and to connect new learning to their previous knowledge. Metacognitive prompts, such as "What main points haven't I understood yet?" lead them to monitor their understanding of the topic and resolve problems.

I want to draw attention how cognitive and social processes are integrated into this type of activity, regarding the three-time frames mentioned earlier. First, on a microgenetic time scale, the writing plan that drives composition could be distributed between internal and external resources. Externally, students are provided with cognitive and metacognitive writing prompts that guide the writing process. Students know that the goal of the learning protocol

is to support their learning, and how to implement cognitive and metacognitive strategies, or they are taught these goals and strategies and internalize them (Glogger, Holzäpfel, Schwonke, Nückles & Renkl, 2009; Roelle *et al*., 2012).

On an ontogenetic time-scale, an interplay also occurs, this time between the cognitive development of the writer and the social process of teaching and scaffolding. For example, most 5th Grade students are not able to benefit substantially from strategy prompts alone; instead they require training in the purpose of the strategies and how to implement them, and they need to access a worked example while they are writing (Roelle *et al*., 2012; cf., Glogger *et al*., 2009; Glogger *et al*., 2012). Conversely, for university students, after initial experience in using the prompts for several writing activities, students learn more from writing activities from which the prompts have been removed than from writing activities in which the prompts continue to be provided (Nückles, Hübner, Dümer & Renkl, 2010). This type of interaction between prior knowledge and cognitive load of instruction is referred to in the cognitive load literature as "expertise reversal," (cf., Klein & Ehrhardt, 2015). Expertise reversals comprise tangible evidence of the importance of integrating social and cognitive variables to explain writing to learn.

On a historical time-scale, we can think of the Freiburg self-regulatory journal as representing the emergence of a new subgenre based on the reciprocal influence of social and cognitive processes. On a social level, the learning protocol could be viewed as the latest of several forms of personal writing that preceded it: The spiritual confessions of the Middle Ages; the personal journals of the Romantic and Renaissance periods; and most recently, the learning journal of the progressive education/language experience era. In each era, these personal forms of writing expressed particular ideologies, such as Renaissance humanism, Romanticism, and child-centered progressive education (e.g., Britton, 1982; Johnson, 2011). Each was intended to support the personal growth of some type –spiritual, aesthetic, or academic. The current form of learning protocol has distinctive characteristics as a genre: It represents an unusual exigency and goal, that is, the use of writing as a vehicle primarily for learning rather than communication. It occurs in a recurring context: It is typically introduced in the classroom after students encounter some new subject matter. It has a distinctive set of roles: The student is a learner, and the teacher is primarily a facilitator of the learner, implying a readership of as few as two. It has a novel text structure, comprised of a series of cognitive and metacognitive strategies externalized on paper. In short, this

is a genre that has evolved as part of a distinctive social context intended to optimize learning for students.

At the same time, the historical emergence of this new subgenre has been clearly adapted to human cognitive abilities and constraints. The self-regulated learning protocol specifically invites cognitive and metacognitive strategies, which were selected because they had been shown in previous research to contribute substantially to learning (Berthold *et al*., 2007; Glogger *et al*., 2012). The results of this historical dialectic between social and cognitive processes have been impressive. The subgenre that immediately preceded learning protocols—the use of learning journals without such systematic prompts—resulted in small and inconsistent effects on learning (Bangert-Drowns *et al*., 2004). In contrast, the new learning protocols with cognitive and metacognitive prompts contribute moderately strongly and reliably to learning (e.g., Glogger *et al*., 2009; Roelle *et al*., 2012).

Argumentation

The second area of research on writing to learn focuses on the genre of argumentation (De La Paz & Felton, 2010; Kieft, Rijlaarsdam & van den Bergh, 2008; Newell & Winograd, 1995). Argument writing is thought to invite critical thinking about the subject matter and depth of understanding. For example, in science students often hold alternative conceptions that differ from scientific conceptions. Argumentation can allow students to compare the standard conception to an alternative conception and evaluate the two based on evidence (e.g., Klein & Ehrhardt, 2015; Klein, Haug & Arcon, 2017). Studies of writing to learn with argumentation have produced results that are positive but uneven, and not consistently more effective than other text genres (Wiley & Voss, 1999; cf. Hebert, *et al*., 2013 for a meta-analysis).

Regarding argumentation as a genre for writing to learn, we can consider the interplay of cognitive and social forces over multiple time frames. On the microgenetic time scale, learning during writing is associated with a moment-to-moment strategy that includes the student making a variety of rhetorical moves, such as stating a claim, giving reasons, identifying an alternative claim, counter-arguments, and rebuttals (Klein, Haug & Arcon, 2017). This production of an argument text can emerge through the interplay of external social, and internal cognitive representations and processes. Moment to moment, external writing prompts support students' argumentation (Ferretti, Lewis & Andrews-Weckerly, 2009). Such prompts could be considered material, social resources, in the sense that they are a

tangible proxy for the teacher or interlocutor in reminding the student to consider other points of view. Conversely, such a strategy can also be executed from cognitive scheme internal to the student (Klein & Kirkpatrick, 2010; Olinghouse & Graham, 2009). Most importantly, these internal cognitive and external social resources interact moment by moment to support learning: In a study on learning science through argument writing, Klein and Ehrhardt (2015) found that for lower-achieving writers, directive presentation of prompts was more effective for learning; however, for higher-achieving writers, non-directive presentation of prompts was more effective for learning (*cf.*, Gil, Bråten, Vidal-Abarca & Strømsø, 2010).

In the ontogenetic time frame, the interplay of social and cognitive forces also occurs. Explicit instruction assists students in learning argumentation schemata and strategies, which in turn supports their ability to use writing for learning (De La Paz & Felton, 2010; Klein & Kirkpatrick, 2010; McNeill & Krajcik, 2009). This process is one of internalization in the sense that the teacher provides explanations, modeling, and support to the student, which the student eventually retains as a higher cognitive function of writing and engaging in critical thinking. On this timescale, there is some empirical evidence for an interaction between social and cognitive processes in affecting working memory load during writing and subject matter learning (e.g., Klein & Haug, 2016; cf., Wiley & Voss, 1999).

Over the historical timescale, there has similarly been an interplay between cognitive and social processes in shaping possibilities for argumentation in writing to learn. Historically, the social purpose of argumentation was often to persuade the interlocutor of a preconceived opinion in the context of law or government. However, at the same time, there has also been a less dominant historical tradition of using argumentation to inquire into an issue or to deliberate on alternative courses of action (Nussbaum, 2008a, 2008b; Walton 1999). In recent decades, this dialogical approach to argumentation has been supported by several social trends, including feminist and Rogerian perspectives on discourse (Belcher, 1997; Hairston, 1976; Lassner, 1990). At the same time, from a developmental point of view, researchers have noted that younger and less effective writers show a "my side bias" in which they fail to address alternative points of view, while more effective writers create more dialogical texts that address contrasting points of view (e.g., Wolfe, Britt & Butler, 2009). Consequently, social and cognitive points of view have converged to support the historical development of more dialogical argumentation as a subgenre for learning.

Social roles in this subgenre differ from those in traditional persuasive argumentation—the audience is primarily the writer, the teacher, and some classmates similarly working toward understanding. Exigencies have varied according to the subject area; they have included learning about how historians interpret conflicting sources to understand events; critically examining alternative conceptions in science; and thinking critically about the social implications of science (Klein *et al*., 2017; Van Drie, Braaksma & Van Boxtel, 2015; Zohar & Nemet, 2002). The text structure of this new subgenre varies but may comprise a balanced presentation of arguments and counter-arguments concerning two contrasting claims, with a conclusion postponed to the end of the text (Klein & Haug, 2016). Empirically, the effects of dialogical argumentation on learning have been somewhat more mixed than theory would promise: For example, Felton, Garcia-Mila and Gilabert (2009) found that deliberation was significantly more effective than a non-prompted condition for learning, but not more effective than disputation (cf., Klein & Ehrhardt, 2015; Klein & Rose, 2010; Klein & Samuels, 2010).

Writing to Learn in the New Literacies: Social, But Also Cognitive

As noted above, to date, much of the research on writing to learn has focused primarily on individual writing from textual sources, giving little attention to the New Literacies. I will use the term "New Literacies" here in a deictic sense to refer to the wide range of changes in media and genre that have recently taken place. To discuss these, I have selected three themes that characterize much of the New Literacies: Collaboration, digital composition, and multimodality, with one practice related to each. I will suggest that several practices of writing (or composing) in the New Literacies can be conceptualized as an integration of the cognitive and the social, with the potential to support content learning.

Collaboration: The Science Writing Heuristic

The Science Writing Heuristic (SWH) is the most extensive and longstanding program of research on writing to learn (Hand, Wallace & Yang, 2004; Keys, 1994; Keys, Hand, Prain & Collins, 1999). The SWH has anticipated several aspects of the New Literacies, including collaboration, multimodality and the use of digital media (Choi, Hand & Norton-Meier, 2014; Demirbag & Gunel, 2014). I will focus here on collaboration. The SWH, in its classic form, includes a cycle of activities: concept mapping, planning and conducting

an inquiry, writing to interpret the results of the inquiry, negotiating these interpretations in small groups, reading, further individual reflection and writing, and final concept mapping.

The SWH approach includes several forms of social facilitation of cognitive processes; these are supported by fellow students, teachers, and external resources. For example, in the SWH, writing is supported with a template, which modifies the traditional genre of the laboratory report in the direction of argumentation; peer feedback provides support for students in evaluating their ideas; writing for a specific audience, such as younger children, leads writers to more fully explain their ideas, and in this way, to clarify these ideas for themselves (Gunel, Hand & McDermott, 2009). The Science Writing Heuristic has repeatedly produced positive effects on learning (Akkus, Gunel & Hand, 2007; Hand *et al*., 2004; Hand, Gunel & Ulu, 2009; Hand, Hohenshell & Prain, 2007; Kingir, Geban & Gunel, 2013).

Writing from the Internet

Writing nonfiction texts using Internet sources appears to be among the most common of writing activities in elementary and secondary schools today; however, to date, the literature on writing to learn using Internet sources has been limited. Initial research suggests that students can adapt their writing strategies to the characteristics of the Internet, suggesting an interplay between cognitive and social, material representations. Skilled writers show a recursive process of setting rhetorical goals and searching for and selecting content on a recursive basis (Leijten *et al*., 2014; Palmer, Teffeau & Pirmann, 2009). This process has been associated with the creation of high-quality texts and learning during the writing process (Martínez *et al*., 2015). The Internet, due to its speed, support for natural language searching, and scope, clearly afford this type of writing strategy (Kirkpatrick & Klein, 2016).

From the viewpoint of WTL, the key question is, what do students learn by writing from the Internet? We can generate some hypotheses using research on Internet-based learning and research on writing from multiple sources. Several recent studies have shown that when people access information on the Internet, as opposed to retrieving it from memory, they are less likely to internalize this information (e.g., Sparrow, Liu & Wegner, 2011). However, they do recall where to access this information (Risko & Gilbert, 2016; Sparrow *et al*., 2011; Storm, Stone & Benjamin, 2016). There is some initial evidence that this offloading of information frees up working memory to think more creatively (Sparrow & Chatman, 2013). At the same time, when people write from

multiple sources, they tend to remember the intertext, which they construct to connect the various sources, and forget specific sources (Braasch, McCabe & Daniel, 2016); argument is a way of engaging the Internet that can elicit critical thinking, and depth of understanding (Wiley, Goldman, Graesser, Sanchez, Ash & Hemmerich, 2009). Taken together, these findings suggest that the intersection of cognitive strategies and external, social resources in the form of the Internet, has the potential to comprise a distributed system that instantiates writing to learn. This suggests that future research on writing to learn should give greater attention to writing to Internet sources.

Multimodal Composition

Multimodal composition has become increasingly important in academic, professional and recreational settings (Bezemer & Kress, 2016; Prain & Hand, 2016; Unsworth, 2011). The growing role of multimodal literacy appears to reflect the interplay of social and cognitive forces in shaping composing.

From a historical viewpoint, humans evolved a cognitive architecture with exceptional visual-spatial ability, that is, the ability to encode, retrieve and transform imagistic representations (Paivio, 2014). Composing written text partially relies on our spatial processing abilities (Galbraith *et al*., 2005; Kellogg, Olive & Piolat, 2007; Passerault & Dinet, 2000). However, printed text has limited affordances for encoding relationships among concepts spatially; in this sense, print literacy left a powerful human cognitive ability less than fully engaged. The development of multimodal representations during the early modern period was critically important to the emergence of the new academic disciplines, particularly science, in which they were used to construct new knowledge (Wise, 2006). However, graphic materials were initially time-consuming and expensive to produce and transmit. Recently, digital media have made visual representations easier and create, store, access, modify, and distribute, so that they are now accessible to a broader group of composers (Bezemer & Kress, 2016; Prain & Hand, 2016). In this sense, a convergence of historical social forces and cognitive forces have contributed to the recent rise of multimodality.

In a study that addressed the ontogenetic time frame, McDermott and Hand (2013) found that training students to embed a variety of kinds of representations increased both the quality of their texts and their science learning. These representations included pictures, graphs, and tables. The researchers assessed how closely the representations were integrated with text on dimensions such as position, the reference to representation in the

text, and accuracy of the representation. They found that a higher score on integration corresponded to greater effects on learning (McDermott & Hand, 2013; cf. Gunel, Hand & Gunduz, 2006).

In the microgenetic time frame, recent studies have compared the effect on learning of a single act of composing with drawing or mixed media versus writing alone. Evidence to date indicates that reading and creating a graphic summary is more effective for learning than reading and creating a textual summary (Leopold, Sumfelth & Leutner 2013). Another study showed that drawing increased comprehension, relative to selecting main ideas and summarizing text (Leopold & Leutner, 2012; cf. Schmeck, Mayer, Opfermann, Pfeiffer & Leutner, 2014). This evidence for the power of drawing challenges the traditional emphasis on writing as a means of learning. The question that remains is whether the advantage of graphic images for learning is unique to concrete, readily visualizable topics (e.g., molecules), or whether the creation of abstract graphic representations (e.g., concepts maps) has a similar advantage over the creation of textual representations.

Conclusion

Here is a recap of the argument to this point:

- Psychological and social perspectives on writing have both been demonstrably successful theoretically, empirically, and pedagogically, so it is worthwhile considering how to connect the two approaches to understanding writing to learn.
- Social and cognitive processes play a role in WTL on historical, ontogenetic, and microgenetic time scales. Theories that integrate these two perspectives, includinggenre as social action, Vygotskian sociocultural theory, and distributed cognition, are applicable to writing as a learning process.
- Recent programs of research on writing to learn have frequently been conceptualized in cognitive terms; however, they also illustrate social processes, particularly the invention of new subgenres.
- Composing in the New Literacies include practices that are collaborative, digital, and multimodal. Each of these can be unpacked into an interplay of cognitive and social processes.

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