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Learning with Multiple Documents

Component Skills and Their Acquisition

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Abstract

The purpose of this chapter is to review the cognitive processes involved in studying multiple documents and to emphasize studying multiple documents as a means for students to learn about complex topics. We define the construct of quality of learning in the context of document-based activities. Then we outline the "documents model framework" that was developed to account for the mental representations and processes that underlie the comprehension of multiple documents. Based on this framework, we point out the specific knowledge and skills that students must acquire before they can successfully take part in document-based instructional activities. Finally, we draw some implications for the design of appropriate tasks, instructions, and materials. We point out the need to provide students with supportive task environments, explicit and complete representation of document sources, and guidelines as to what to read and how to read it, in order for them to come to a full understanding of intertextual contents and relationships that make up the discourse representation of complex content-area knowledge.

Studying multiple documents to learn about a topic can lead to a deeper, more complete understanding of the content (Wiley, Goldman, Graesser, Sanchez, Ash, & Hemmerich, 2009). Without some support, however, it can also be a challenging experience for students. Consider the teenage student who is asked to write a research report for a history or science class. The student is likely to be asked to take a stance on a particular claim, such as the prompts or controversies shown in Table 13.1. These prompts and the provided

This research was supported by the Institute of Education Sciences, U.S. Department of Education, through Grant R305H05133 to Northern Illinois University, and by the Region Poitou-Charentes (France) through a visiting researcher grant to the second author. The opinions expressed are those of the authors and do not represent views of these institutions.

TABLE 13.1. *Example Prompts (Controversies) Used for Student Reports in Multiple-Document Studies*

History
"To what extent were Roosevelt and his administration responsible for the 1903 revolution in Panama?" (Britt et al., 2000)
"What was the primary cause of the Salem Witch Trials?" (Britt et al., 2000)
"To what extent was Carnegie responsible for breaking the Union at Homestead?" (Britt et al., 2000; Britt & Aglinskas, 2002)
"What was the Gulf of Tonkin resolution and why did Lyndon B. Johnson push Congress to pass it in August of 1964?" (Britt et al., 2000)
"Take the role of historian and develop an argument about what produced the significant changes in Ireland's population between 1846 and 1850." (Wiley & Voss, 1999).
Science
"Write an essay about the causes, consequences and or best solutions for the problem of climate change." (Bråten et al., 2009).
"What caused the eruption of Mt. St. Helens?" (Wiley et al., 2009).
"Imagine that you have to write a brief report to other students where you express and justify your personal opinion about how climate changes may influence life on Earth and what are the causes of climate changes. Base your report on information included in the following five texts. You will find info which is relevant for writing your report and info which is not relevant for writing it. Use the most relevant information, and try to express yourself clearly and to elaborate the information." (Gil et al., 2010).
"What is the main difference between Thomson's and Rutherford's models [of the atom]?" (Rouet, Vidal-Abarca, Bert-Erboul, & Millogo, 2001).
"Write a one-page argument based on this set of texts. The argument will have to present the main ideas expressed in these texts on the subject of social influence." (LeBigot & Rouet, 2007).

materials are much like the history document-based questions (DBQs) that are used as part of Advanced Placement courses in the United States.

Although the student may be tempted to take a low-effort approach (e.g., paraphrase what they find on the topic from Wikipedia), teachers generally assign such tasks to stimulate deep processing of content, so the assignment usually requires the student to cite several sources and transform the information to support a position. Assignments such as these require that the student coordinate a series of somewhat iterative steps. Students must figure out what they already know and what they need to know to write the essay. Then they must begin to search for information on the topic and begin

reading documents to acquire content. Because no single text presents a sufficient description of the complex situations or phenomena such as those in the prompts in Table 13.1, students need to read broadly enough to gain enough knowledge to form their own perspective based on available evidence and theory. Thus, the knowledge acquisition phase requires the integration and transformation of content that is partially overlapping, partially unique, and partially contradictory, to create a broad and comprehensive knowledge base.

To further complicate matters, students must organize this content to create an essay that addresses the prompt. So students must have a functional understanding of the genres and the task requested in the prompts such as compare-contrast (e.g., "What is the main difference between Thomson's and Rutherford's models [of the atom]?"), or present an argument (e.g., "To what extent were Roosevelt and his administration responsible for the 1903 revolution in Panama?"). Each of these component steps is complex in its own right and they are closely interrelated, leading to the need for flexible processing of each step (Rouet & Britt, 2011).

Given the complexity of each of the processes involved in writing a research report, it is unreasonable to expect students to skillfully approach such assignments without instruction and supports (Britt & Aglinskas, 2002; Rouet, Britt, Mason, & Perfetti, 1996; Stadtler & Bromme, 2007). Several studies have found that even skilled high school students and college students need to develop these skills. For instance, Wineburg (1991) found that advanced high school students failed to encode or evaluate source information prior to reading the content of a document and viewed the textbook as most trustworthy. Since that time, many others have found similar problems with high school and college students' spontaneous use of these skills (Britt & Aglinskas, 2002; Rouet et al., 1996; Rouet, Favart, Britt, & Perfetti, 1997; Wiley et al., 2009). In fact, several studies have shown that high school students will readily use fictitious information from novels and films as support in their history essays (Britt & Aglinskas, 2002; Seixas, 1994; Wineburg, 2000).

Thus, we propose that the use of multiple documents in educational contexts contributes to quality of learning to the extent that students possess the required skills and knowledge to successfully engage with and make use of document information. Because multiple documents, whether printed or online, play an increasing part in contemporary teaching practice, we argue that the benefits of acquiring document-literacy skills make it worth the cost of supporting the development and use of these skills. We begin this chapter with our definition of quality of learning, and then we present two theoretical frameworks that we have proposed to account for the processes involved

in learning from multiple documents and the type of mental representations that comes out of multiple-document processing (Britt, Perfetti, Sandak, & Rouet, 1999; Perfetti, Rouet, & Britt, 1999; Rouet & Britt, 2011). Finally we present implications that these models have for students' learning from multiple documents.

Quality of Learning

In the context of the present chapter, quality learning can be defined as combining multiple informational artifacts to construct a coherent representation of situations. Quality learning involves not just acquiring facts about a topic or a situation, but also gaining an awareness of how these facts come to be established (i.e., what sources they come from) and the degree of certainty (or caution) with which they must be taken. We further contend that any deep engagement with textual materials is contingent upon students' objectives, which, in learning contexts, are most often a function of their learning task. We suggest that some task contexts are more productive than others. More specifically, explanation and argument tasks are critical for both developing and assessing students' learning of causal explanation (mechanisms and motivations) and ability to justify hypotheses or interpretations (see Table 13.1). Several aspects of this definition require elaboration.

Situations

Our definition of quality learning focuses on students' learning about *situations*, such as a steel mill strike or a war in Vietnam, and *phenomena*, such as volcanic eruptions or movement of blood through the heart. Such learning does not require just an accumulation of facts, but rather an understanding of how things work and why people do things. These situations can include both human and non-human agents, motives, and actions. Although this includes both static events and dynamic processes, the focus on mechanistic and motivational causes requires more than the description of a single state of affairs. More specifically, learners must be prepared to consider, evaluate, and integrate alternative explanations or interpretation, together with the sources that support – or challenge – each of them.

Multiple Informational Artifacts

When we refer to informational artifacts, we mean all types of materials that are used in educational contexts such as texts, pictures, data tables and figures, cartoons, even Adobe Flash®-style simulations. For convenience, we refer to these materials as documents, but we do not mean only textual

materials. For instance, in the document set used to understand the changes in Ireland's population, Wiley and Voss (1999) used narrative texts (biographical accounts of key figures), legal texts (descriptions of key Acts), a map, and numerical data (population data and economic statistics).

One may ask why we believe that deep or quality learning requires one to combine multiple informational artifacts. The main reason is that documents are written from an author's perspective, and no single perspective can ever be a complete and exhaustive presentation of a phenomena or situation. Consider the student trying to come to an educated interpretation of the events in Panama around 1903, when the U.S. effort to build a canal was aided by a revolution in Panama against Colombia. From the time of the events (and even before) to present times, there has been a continuous production of documents that tell the story (or some aspect of it) from different perspectives and for various purposes (Perfetti, Britt, Rouet, Georgi, & Mason, 1994). Some of them are primary documents produced by participants at the time of the events for private or public purposes. Others are comments, essays, and reviews written by various types of authors (including historians, politicians, and novelists) with a great variety of motives and intended audiences. No single perspective accurately and completely captures the entire situation. Documents may focus only on a particular aspect of the situation or phenomena (e.g., causes, consequences, solutions). Authors may also write from a particular disciplinary perspective (e.g., geographical, economic, political, historical, and cultural) and can be affected by their theoretical and methodological approach. Finally, each source is guided by their communicative intent, and bound by those events to which they had access. Because authors are biased by their knowledge, experiences, and motives or worldview, their framing or interpretation as well as their selection of facts, claims, and arguments are presented through that filter.

In the Panama example, reading a textbook excerpt will give the student a superficial understanding of the events and their time frame. Reading any single further document, such as President Roosevelt's writings and speeches, will add to this understanding; however, because the president was motivated to portray U.S. actions as irreproachable, the information may be suspect and many other parties' beliefs, motivations and actions left out. To come to an educated understanding, students need to read multiple documents from several perspectives, such as (1) accounts by historians; (2) U.S. President Roosevelt's statements, letters, and autobiography; (3) the memoires of the Frenchman Bunau-Varilla who had financial interests in getting a canal in Panama; (4) transcripts of the U.S. military correspondence; and (5) the Colombian government's internal meetings and negotiations with the Panamanians.

Using multiple documents is not just important because of the limits of any single document; it is also useful so as to not deceive students that an author or text could be complete and unbiased. Reading multiple interpretations or multiple theories highlights for students both the social nature of text and the complex relationships between documents and the content they present. It also provides students an opportunity to understand complex, uncertain situations, as opposed to just memorizing factual knowledge.

Creating a Coherent Representation

Simply providing students with multiple documents, however, is not enough to lead to deep learning. Quality learning is not simply learning someone else's interpretation or causal explanation, but being able to combine this information in a reasoned way to *create a coherent representation*. At a minimum, this involves being able to represent multiple perspectives and interpretations, working to resolve (or allowing to coexist coherently) conflicting information, and understanding how information functions as part of an author's argument. While identifying the reasons that a secondary source uses to support a claim is important, deeper learning would go beyond simply identifying these reasons to recognizing how new information might be used as a reason or counterargument in other sources that address the same controversy or main claim.

Explanation and Argumentation

We also propose that learners' understanding of the task matters for supporting engagement in and assessment of quality learning (Rouet & Vidal-Abarca, 2002; Snow, 2002), especially within a school domain. Creating a task that sets goals and standards for engagement with texts is critical to guiding the types of representations that we believe are necessary to learn in a meaningful way from multiple documents. Worksheets with factual questions will not lead to these types of representations. It is not a trivial task for students to engage with texts in a meaningful and deep way. When asked to read documents in underspecified task contexts, students will likely rely on their own interpretation of the task and settle for more shallow objectives such as memorizing names and dates or reducing the contents to a gist representation, thereby learning each author's perspective in an isolated way.

We believe that tasks that focus on explanation and argumentation will help students engage in the type of processing that will result in quality learning. Explanation is at the heart of understanding the causes of events and phenomena. Often, however, these explanations are somewhat tentative, and we cannot be completely certain of their truth. In history and science, we

strive to be as accurate as possible, but often we are relying on hypothesized mechanisms and motivations. The test is how well a hypothesis or interpretation is supported by the available data. In science this means weighing theory-evidence relationships, and in history it involves comparing documentary evidence to interpretations. Argumentation is the method of dealing with the inherent uncertainty within the disciplines.

Argumentation, as an instructional task, has also been shown to lead to increased transformation of information from multiple documents. For instance, Wiley and Voss (1999) presented undergraduates a set of eight primary documents and found greater integration (as measured by transformations and causal connections) and more knowledge of the content (as measured by inference verifications and analogy judgments). Thus, argumentation tasks can accomplish two goals: they aid students in their interpretation of documents and foster a generally deeper engagement with text.

Summary

Quality learning may be defined as the ability for students to represent situations through multiple perspectives and to make use of multiple sources of information in addressing the demands of deep learning tasks. These are, of course, ambitious objectives for instruction. To better understand why students experience difficulties when working with multiple documents, it is useful to call upon a framework for understanding the core cognitive steps and processes involved in those tasks. This is the purpose of the next section.

Quality Learning from Multiple Documents: Cognitive Representations and the Processes That Support Them

The cognitive processes involved in comprehending multiple documents are arguably more diverse and complex than those involved in reading a single passage of continuous text. Readers of multiple documents may choose which document to read first, when to interrupt their reading of that document, where to go next, and so forth. Moreover, readers need to integrate information not just within, but also across the documents included in a set. Therefore, one needs to understand how students manage to access, evaluate, and integrate information from the texts at hand.

Our prior research has led to two proposals that are relevant here. One is the MD-TRACE model (for Multiple-Document Task-based Relevance Assessment and Content Extraction), a description of the structures, processes, products, and resources that we think are required of such multiple document-learning tasks (Rouet & Britt, 2011). The MD-TRACE model

originated from an attempt to expand earlier cognitive models of information search to account for the search of complex information in multiple text passages (Rouet, 2006). We focus here on one core feature of the MD-TRACE model: the readers' construction of a Task model. The second proposal is the documents model framework (Britt et al., 1999; Perfetti et al., 1999) that accounts for how readers manage to integrate multiple and possibly conflicting sources of information into coherent memory representations.

Students' Construction of Task Models

According to the MD-TRACE model, students given the task of learning from multiple documents to write an argument or explanation of a situation must begin by understanding the task instructions and using this information to form a task model. The task model includes the *task goal*, *actions to achieve the goal* (i.e., subgoals and procedures for achieving these goals), and a *set of criteria* for reaching those goals.

The creation of a task model begins with the task specifications such as those shown in Table 13.1. For example, consider the task of writing an argument to address the following controversy: to what extent were Roosevelt and his administration responsible for the 1903 revolution in Panama? To properly turn these task specifications into goals and action plans, students have to not only know about the nouns (e.g., Roosevelt administration, revolution, and Panama); they also must know about the action words (e.g., writing an argument and "were responsible"). Other important task action words may include "explain," "compare/contrast," and "locate." To create a task model, students must have an understanding what a "good" task product looks like. In this case, the task goal may be an argumentative essay that takes a stand on the controversy and is supported by discipline-appropriate evidence and deals with evidence or interpretations that are contrary to the student's own stance. Students also need to be aware of practical constraints on their task – for example, how much time is available for study and how important is their performance on that task.

Next, students must turn this task goal into a set of actions. Actions are activities such as reading enough information to form an educated stance on the controversy (main claim), identifying possible supporting reasons and evidence, selecting strong reasons with respect to available evidence and audience, identifying other-side positions that must be addressed, and identifying appropriate responses or rebuttals for those counterarguments, if possible.

Finally, students must identify the criteria for achieving the task goals. For instance, they may decide they want three well-supported reasons and one, rebutted, other-side argument with explicit connections to help students'

better understand the argument. Alternatively, they may think that a strong, convincing argument for a particular audience would not include other-side information.

This is a challenging task, even for undergraduate-level students reading non-disciplinary content. We have found that many students do not know that an argument is more than simply stating one's opinion. Others fail to write arguments with a stable claim, include elaborated supporting reasons, or consider the audience, particularly other-side information (e.g., Wolfe, Britt, & Butler, 2009). Part of the difficulty students have is owing to a lack of genre knowledge. This is important because knowledge of the genre guides the creation of certain task goals and subgoals. Indeed, college students can be greatly aided by providing a clear statement of what is required in the assignment instructions (Wolfe et al., 2009), thereby directing students to set up specific subgoals.

We will discuss the decision-making steps later, but for now it should be mentioned that students must s*ustain and monitor the success* of these task goals and subgoals (action plan) throughout the entire task activity. They also must determine their information needs by comparing what they know about the topic (i.e., prior knowledge) to what is required (e.g., task model). If students decide that they need more information and cannot simply complete the task from what they already know, they will have to seek out and read more information on the topic. For the tasks we are considering in this chapter, students will know that they need to consult multiple documents. They then begin selecting and reading documents to build up a representation of the integrated situation and support for their interpretation of the situation. We refer to students' representation of information from multiple documents as a documents model.

Documents Model

According to theories of single-text comprehension (Kintsch 1988, 1998), readers construct three layers of representation: a *surface code*, a *textbase*, and a *situation model*. Upon reading a single text, the reader decodes the verbatim text to construct a representation that maintains the exact lexical and syntactic surface representation of the text. The first level of "meaning" is the textbase in which more abstract propositions are constructed by making inferences to coherently related parts of the text. Deeper meaning is then created by using prior knowledge and inferences to interpret the textbase propositions and to construct a situation model. This situation model is an elaborated interpretation of the situation described by the text and goes beyond the information stated in the text.

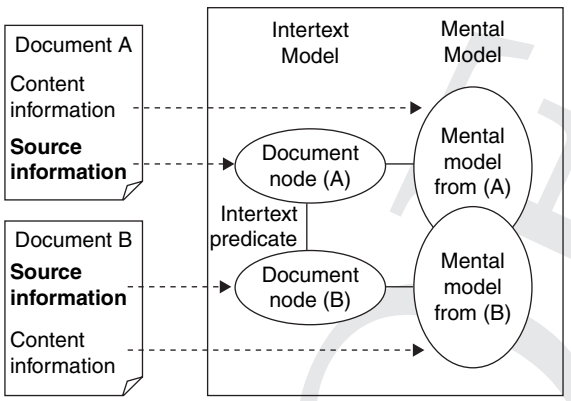

FIGURE 13.1. Components of a documents model (adapted from Rouet, 2006).

According to the documents model framework (Britt et al., 1999; Perfetti et al., 1999), learning from multiple documents requires two additional levels of representation: the intertext model and the integrated mental model of the situation described as shown in Figure 13.1. The documents (A and B) read by the hypothetical student are represented on the left side of the figure and the documents model is represented by the large box on the right. The intertext model includes both a document node for each document and intertext links (solid lines) between document nodes and from document nodes to content. The integrated mental model is represented by the ovals on the far right.

The documents model begins with the assumption that we experience texts as social entities, not just a series of linguistic propositions (Wineburg, 1994). Texts as social entities include a large number of features beyond propositional content, such as the author, genre, publication date, intended audience, purpose, and so forth, which can be subsumed under the concept of "source" (Britt et al., 1999; see also Table 13.2). Thus, a reader's representation can include information about the source of the document (e.g., who wrote it and for what purpose) and reflect that the information came from that source. Representing source information is important because sources have different expertise, knowledge, and biases (e.g., witness, Latin American historian, U.S. congressional representative, or participant in the events). For example, Wineburg (1991) describes the surprise of a student reading a document on the Battle of Lexington, who did not realize until after reading that the document was written by the opposing side, stating: "Oh my God, it's British." Or consider a situation in which a student reads a text that states that volcanoes are ducts for the Earth's tears.

TABLE 13.2. *Possible Document Node Features (Examples Taken from Britt & Aglinskas, 2002)*

Feature	Feature	Definition	Examples
Source (Author)	Name		
	Position / Status	Occupation or credentials	President; Professor
	Motivation	Reasons for the author writing the document	Wanted to make himself look good; President would say anything to keep from being impeached
	Access / Participation	How author came to know about events that describe	Eyewitness account; He doesn't exactly know what happened, receiving hearsay
	Evaluation	Critique or opinion of the author	Author is biased
Source (Setting)	Place, Time, Culture		
Source (Form)	Date	Time period in which document was written	Written with the ability to see retrospectively
	Type	Form of document; publisher; style	Personal letter, Official record, Treaty
	Evaluation	Critique or opinion of document	College text would not print false facts; As a treaty it has no bias
Rhetorical goals	Intent: inform, persuade		
	Audience		
Content	Summary point	Macro proposition of text	

Representing source information is also important because it allows one to create a coherent representation from otherwise incoherent or discrepant information. For a real-world example, consider the simple example of a parent who asks his two children which of them broke the vase. Johnny says that Sarah threw the ball and it knocked over the vase. Sarah says that Johnny threw it. Both situations cannot be true, so the parent cannot simply integrate the sibling's texts into a coherent model of the vase-breaking situation. The parent's trying to resolve the situation would have to represent that the accounts are

discrepant and then consider the source (neither Sarah nor Johnny want to be punished for breaking the vase). Although this is an extreme example of discrepancy, the point is that we all have experience from our everyday lives with the need to "consider the source" when trying to create a coherent model of situations from discrepant accounts. Discrepancies and competing theories are also common in history and science. Consider the examples of texts adapted from in displays of science for laypersons shown in Table 13.3. In such cases, the museum acknowledges competing theories of why dinosaurs vanished and what caused the salt dome. Texts that contain such references allow one to realize that different theories or perspectives exist about the causes of the described situation. These statements also show how qualifying content by its source allows one to coherently represent conflicting information.

In argument and explanation tasks that require students to address topics that do not have a simple and definite answer, it is especially important for students to treat documents as entities and to consider the source. For example, when reading about climate change, one may encounter a text by a scientist that provides evidence that man-made discharges of greenhouse gases have contributed significantly to the temperature changes observed in the last fifty years, and encounter another text by an oil-industry spokesperson stating the recent temperature changes are part of normal climate variation and that recent temperature changes are mostly owing to astronomical conditions and not human activity. To represent these opposing interpretations of the data and opposing causal explanations, students must represent that these seeming inconsistencies are actually different perspectives by different authors (see Bråten, Strømsø, & Britt, 2009 for just such an example). Thus, to adequately represent the information from these two texts within a single, coherent representation, one would have to explicitly represent each view, the fact that they are discrepant, and relate each to the document entities from which they originated. The document entity is comprised of not just the source (e.g., who is writing, for what purpose, when, and what they know about the situation), but also other text characteristics (e.g., written for general audience, uses obviously biased language, etc.). Representing information about the document and its relationship to the content is precisely the purpose of the documents model's first additional structure: the intertext model.

Intertext model. According to the documents model framework, source information is represented by an additional level of organization, which we call the *intertext model.* The intertext model includes *document nodes* (see document nodes [A] and [B] in Figure 13.1) and *intertext predicates* (see the solid lines in Figure 13.1). Document nodes can represent what one knows or thinks about the source or the text (see Figure 13.1). Each document node

TABLE 13.3. *Excerpts from Actual Science Museums Displays (Source Information Is Highlighted for Illustration Purposes)*

Excerpt 1.	Why did the dinosaurs vanish? Dinosaurs and many other life forms disappeared around 65 million years ago in a mass extinction. The sediment record for this time shows a thin layer of clay with high iridium content. Iridium is a rare metal on Earth. Most scientists think that this layer is the sign of at least one large asteroid striking this planet. A very large crater has been found off the Yucatan Peninsula of Mexico. Other scientists suggest that the iridium layer was formed by huge volcanic eruptions. In either case, large amounts of dust and ash would have produced acid rain and hidden the Sun. The resulting colder climate and reduced plant life could not have sustained animals as large as most dinosaurs.
Excerpt 2.	What should we do about climate change? A very small group of scientists believe that no actions need to be taken at this time and that the Earth will find a way to re-balance itself. Most climate experts, however, insist that we are at the point where we must focus on mitigating and adapting actions. Mitigation focuses mostly on conservation efforts that will lessen the impacts of climate change on people, economies, and ecosystems. Adaptation encompasses the changes that societies will have to make in order to live with climate change.
Excerpt 3.	A Salt Dome? Everywhere in this region you see rocks in layers – orderly layers that lie nearly flat, one on top of the other. But not at Upheaval Dome. Here, exposed in a crater-like depression more than two miles wide, the rock layers are titled and displaced, as if they'd been "heaved up." What happened, and why? Some geologists trace the origin of Upheaval Dome to the impact of a huge meteorite. But others see evidence of a more gradual development, controlled by forces below ground. Prominent among these explanations is the salt dome theory. Beneath Upheaval Dome lies a massive body of salt that evaporated from ancient seas. Over the salt laid hundreds of feet of sediments which later formed the rock layers of this area. According to the salt dome theory, the buried salt, which is plastic under pressure, flowed upward here, pushing up the overlying rocks to form a dome. Erosional forces then stripped away the top of the dome, exposing the deformed layers you see today.

can have many different features including features of the author (e.g., name, position), setting (e.g., where the document was written), form (e.g., date it was published and the publisher), and rhetorical goals as shown in Table 13.2. These features can include both objective information (e.g., person's name or date of publication) and more evaluative information (e.g., the author is

biased, "the publisher has high standards"). Of course, most students in a scholarly context will not represent all of these, but most are detectable by at least some of our undergraduates (Britt & Aglinskas, 2002). At one extreme, a student may not intentionally encode any of these semantic features and may only incidentally encode perceptual or episodic features (e.g., the blue covered book read in class on Wednesday). This may be especially likely when the document itself does not provide any relevant information (as is true of many Web sites). Such unelaborated features may fade as quickly as the verbatim surface features of the text (see Kim & Millis, 2006). At the other extreme is the expert who is highly knowledgeable about the authors, genre, and topic and is motivated to obtain a complete and accurate model of the situation described by the various texts.

Document nodes may be connected to each other (e.g., Sarah and Johnny disagree, or the scientist disagrees with the oil spokesperson) and to content (e.g., scientist said that the earth was warming .05 degrees per year) through intertext relations (see Figure 13.1). It is actually these intertext links that allow one to create a coherent and integrated representation of conflicting theories and evidence, because the reader qualifies the conflicting information as assertions attributed to a given author. The intertext links can include a variety of rhetorical relations such as corroborating, supporting, and contrasting, represented through *intertext predicates* such as "agrees with," "disagrees with," "supports," "opposes," and "provides evidence for/against claim." We suspect that these links can be quite specific, such as "agrees that problem exists but disagrees on cause of global warming." Occasionally when an author actually refers to another document, these links can be author-initiated (e.g., "According to the scientist"), but more commonly students must generate the links themselves.

The extent to which students create and fill in information for each text's document node and the particular intertext links created will depend on many factors. At one extreme, students may form a "mush model" (Britt et al., 1999) in which students do not represent any meaningful information about the source (i.e., no document nodes created), but simply add new information to what they already know without worrying about who said what (i.e., no intertext links created). At the other extreme, students may create a semantically rich document node for each text and may directly note where all information came from. This extreme is less likely to occur because of the high cognitive processing demands. According to the documents model framework, performance will generally fall between these two extremes, with only the initial information in a document and the most important information becoming explicitly linked with their source.

While we currently do not have a complete theory of when these reader-initiated links will be made, we have found that conflict or discrepancy increase attention to source information (Rouet, Britt, Caroux, Nivet, & Le Bigot, 2009). Other factors, such as presenting source information prior to the content, using source information to select a document and including distinctive, semantically rich sources, could impact the interpretation of content by increasing the availability and salience of source information. Task instructions, such as "learn an author's version of the situation or phenomena," would also likely lead to greater content to source linking.

Integrated mental model. In addition to the intertext model, the documents model framework also proposes that students trying to learn through multiple texts also must create an integrated *mental model* of the situation or phenomena (see the right side of Figure 13.1). We previously referred to this integrated model as a "situations model" for historical reasons (Perfetti et al., 1999). The documents model was originally created for the representation of history content and was based on text-processing models of event-based, narrative information. In extending the model to topics about the natural world, we now refer to a mental model as the idealized representation of the integrated semantic content of the complete meta-situation or phenomena. Although others (Gentner & Stevens, 1983; Johnson-Laird, 1983) have used this term in a more theory-laden way, we intend it simply as an internal representation of situations and phenomena described across texts (see also Wiley, Griffin, & Thiede, 2005).

The content and the structure of the information in a mental model are equally important. The content that students will need to integrate from most academic multiple document tasks will be a complex mixture of information. Some will involve overlapping information that is presented in more than one text (e.g., "the earth's average temperature rose by approx. 0.5 °C in 150 years"). Most will involve unique information that is mentioned in only a single text (e.g., "Every day, 2,800 tons of CO_2 is being pumped down into the sandstone formation instead of being released into the atmosphere"). Most challenging, however, are the contradictory facts, beliefs, motives, and events that are presented across texts (e.g., "These increases in CO_2, CH_4, and N_2O are due to manmade discharges and have resulted in a *stronger* greenhouse effect" versus "We still do not have a basis for establishing that human pollution of the atmosphere is the main cause of climate change").

The structure of the information in the mental model will depend on the content and the nature of the task. For instance, the content represented in the mental model can be structured as a narrative ("the events in Panama leading up to the revolution"), as a description of a dynamic process

("how forces affect volcanic activity"), or as an argument ("what evidence supports each interpretation of the narrative or each theory of the causes of volcanic eruptions"). The important point here is that in a multiple-document situation, the reader is the author of the integrated mental model, and this generally requires that the content be transformed and organized. It is this transformative process that leads to deeper learning of the content (Wiley & Voss, 1999).

For many research papers and assignments, the structure of multiple-document content is often an argument about competing narrative accounts or competing theoretical explanations. For this reason, students must also be skilled in comprehending, evaluating, and producing arguments. Put simply, an argument is a main claim that asserts a position on a controversy (e.g., the United States was responsible for encouraging the revolution in Panama) supported by reasons or evidence intended to increase one's acceptance of the truth of the main claim (Toulmin, 1958). Additionally, arguments presented in academic contexts are usually expected to take into account competing theories or interpretations (i.e., counterarguments) and to address evidence that does not support one's main claim.

To successfully write an argument for one of the prompts in Table 13.1, students must understand the meaning of the claim predicate (e.g., "to be responsible for events/revolution," "to be the cause of") and the type of evidence and examples that can support such claims in the given discipline (Britt, Kurby, Dandotkar, & Wolfe, 2008). As students read the documents, they have to organize their mental model around their claim and keep this in mind when evaluating how the evidence supports or fails to support the various other stances surrounding the claim. Students must represent competing theories or accounts and what evidence supports each interpretation. To do so, students have to represent the content from individual texts, many of which may be argumentative texts that present one or more main claims supported by evidence and reasons, and often present conflicting information that may or may not be rebutted. Thus, students must have knowledge about the genre and an *argument schema* that guides their interpretation of the texts.

The content of the documents that students read may have unique, overlapping, and contradictory information, but students may or may not accurately note these cross-document relationships. Just as we noted for linking source information, students will vary in the extent to which they make cross-document content links. At one extreme, students may either not integrate information across documents at all or do so only minimally. Britt et al. (1999) refer to the situation where one represents the content from each document

as an isolated set of information as a "separate representations model." At the other extreme, students may completely integrate all related information into a completely integrated model of the situation. In many cases, this is precisely what we are expecting students to do when reading multiple documents. Again, we currently do not have a complete theory of when and how integration will occur. The documents model framework does, however, identify a couple factors that are expected to affect this process. Document sets with little lexical and semantic overlap across documents may not promote integration, whereas including documents with a high degree of overlapping events and concepts have been shown to lead to more integration (Kim & Millis, 2006; Kurby, Britt, & Magliano, 2005). This overlap is expected to lead to reactivation of relevant information from prior documents the student has read. In addition to simple overlap, other factors that increase reactivation such as writing summaries of each text have been shown to increase integration (Britt & Sommer, 2004). Finally, explicit instructions to integrate have also been shown to be effective (Britt & Sommer, 2004).

Important Decision Steps Supporting the Construction of Task and Document Models

The MD-TRACE model identifies several important decision steps that we believe support the creation and updating of both the Task and Documents models. These are discussed briefly in this section (see Rouet and Britt [in press] for a more detailed treatment).

Assess information needs. The first decision students have to make is whether to read information prior to answering the question. There are two clear challenges in making this decision. The first is the creation of an appropriate task model – a goal, actions to achieve the goal, and criteria for achieving this goal. To the extent that the task instructions explicitly state the goal and specify criteria that include evidence and support from multiple documents, students will have a more or less clear indication that they should consult and use information from the documents. The second challenge is sustaining and monitoring the task goal and subgoals throughout the complete task activity. There is evidence that younger students tend to forget their search goals en route (Rouet & Coutelet, 2008), owing in part to their encountering distracting information. Furthermore, in complex document-based activities, students frequently have to dynamically update their task model as a function of the information they acquire. For instance, in the Panama example earlier in the chapter, after acquiring a U.S.-centered account of the events, the student may consider looking for other points of view. This calls on higher-order learning skills such as self-regulation (Azevedo, Guthrie, & Seibert, 2004).

Select relevant material. A second decision point occurs when assessing documents. Students have to select relevant documents by looking at title pages, menus, sources, or output from search engines. This requires knowledge of these artifacts and skill in using them. Students also have to know the meaning of the specific words such as proper names, concepts, and vocabulary including potential synonyms to guide the search. Once a document is selected, they have to evaluate the relevance of the document to the task model. More elaborated factual and conceptual knowledge will enable students to determine whether content is related and to help them create a coherent mental model of the integrated situation or phenomena. According to the MD-TRACE model, students will also take into account the perceived cost of accessing (e.g., difficulty in retrieving a document) and cost of processing (e.g., document readability or prior knowledge requirements) documents during this relevance evaluation process.

Assess the product. The final decision point regards task completion. To make this decision, students must compare the task product (e.g., essay) to the task model. If students determine that the product does not meet the goals of the task, then they have several choices such as continuing to read and/or write (i.e., build up documents model or task product) or they can change their goal (e.g., criteria or what they think is needed if they could not find it). Again these decisions presumably draw on students' self-monitoring and regulation skills (Coiro & Dobler, 2007).

In addition to decision-making steps, there are also processes that support the creation of the documents model. These include sourcing (i.e., attending to source information prior to interpreting its content), corroboration (i.e., directly comparing information across documents for consistencies and discrepancies), integration (i.e., reactivating prior information to interpret content and construct a mental model of the situation or phenomena), and search. A detailed presentation of these processes is beyond the scope of this chapter; it is important to note, however, that each of these processes has to be learned and may create a problem to the extent that their execution is effortful or not available as a resource for the students.

The growing empirical base suggests that students have difficulty with the processes of monitoring, sourcing, corroboration, integration, and search. For instance, in contrast to domain experts, high school and college students often fail to spontaneously attend to source information (Britt & Aglinskas, 2002; Britt, Wiemer-Hasting, Larson, & Perfetti, 2004; Rouet et al., 1996; Rouet et al., 1997; Wineburg, 1991), and undergraduates generally evaluate the trustworthiness of documents based on content, whereas more knowledgeable students (e.g., graduate students in history) generally consider

characteristics of the source (e.g., author and document type) (Rouet et al., 1996). This lack of spontaneous sourcing is not surprising given that such strategies take effort, skill, and knowledge, and students often do not receive systematic training in these skills (Wiley et al., 2009).

Implications for Tasks, Instruction, and Materials

From the literature review and discussion presented earlier, it should be clear that educators cannot expect great instructional benefits from merely "dumping" multiple documents on students, and educators certainly should not expect students to use the documents in a manner that supports the development of a quality documents model or task product without guidance. Multiple document assignments (including those using Web-based informational resources) are very demanding, and it may require special attention to external and internal resources to help students complete such tasks in a beneficial manner.

Such assignments occur in an environmental context that includes a set of *external resources* that are made available to students. The key resources can be classified into supports and materials. The supports include the task specifications, management tools, and instructions. Task specifications include the prompt (i.e., task statement), any explicit directions for carrying out the task, and level of performance expected. This teacher-provided information will be instrumental in guiding students in creating an appropriate task model. Management tools include search tools (e.g., library catalogs, search engines, and text organizers), monitoring tools (e.g., tools or supports for highlighting and annotations, check marks on menus to show documents visited), and content management tools (e.g., multiple windows for document comparison, tools for creating content maps, and tools for outlining arguments). Instruction, in the form of tutorials for teaching students features for source evaluation or key components of argument analysis, can come from a teacher, computer agent, or peer. It can be Web-based or lecture-based and can include practice opportunities with or without individual feedback. The materials include the actual documents. These can vary on many dimensions such as the amount and location of source information, the type of documents (e.g., primary sources, data tables), variety of interpretive perspective, complexity of material, directness of relevance to prompt, and overlap of information across documents.

The environmental context can be very impoverished, such as a student being given the prompt "find out about U.S. President Roosevelt's role in the Panamanian revolution" using a search engine and the entire Web without

any environmental support or agents. Or it can be very supportive, such as instructions to take a stance on a specific controversy and support this stance by presenting evidence from a tailored set of documents using an environment that provides tools for creating a documents model such as SEEK (Wiley et al., 2009).

The degree to which one requires a more supportive set of external resources will be largely affected by the *internal resources* available to students. By internal resources we mean general knowledge (e.g., vocabulary, conceptual, factual, genre) and skills (e.g., search, reading, reasoning, perspective taking, and memory skills, especially executive control), as well as document-specific knowledge and skills (e.g., sourcing, integration, argumentation, evaluation, managing contradiction) and beliefs (e.g., epistemic, cultural, self-efficacy).

Based on prior research and the framework provided by MD-TRACE, we present several suggestions in terms of features of the supports and materials that may affect the way students perform on multiple document tasks.

Task Model

Several aspects of the external and internal resources will affect the creation, updating, and monitoring of the task model. In Table 13.4 we have listed several supports that may help in this process. We have numbered the paragraphs that discuss each one for easy comparison with the table.

Creating task goals, action plans, and setting criteria. The teacher's framing of the task is a critical factor in how challenging students will find the task of creating an initial task model. Many factors affect students' skill in performing task-oriented reading assignments and these will impact the appropriateness of materials and tasks.

1. The task model that is created as a result of the assigned prompt requires that students have a functional understanding of the requisite discourse schema. In the case of a summary or narrative, we expect that even young students have such a schema (Stein & Glenn, 1979). For the argument prompts, however, we cannot be as confident. Although, the use of an argument schema to organize information from argumentative texts seems to develop as early as fourth grade (Chambliss & Murphy, 2002; Golder & Coirier, 1994; Knudson, 1992, 1994), students may continue to have difficulty comprehending (Larson, Britt, & Larson, 2004), evaluating (Larson, Britt, & Kurby, 2009), and producing arguments (Wolfe et al., 2009) well into college. Fortunately, we have found that many college students are aided by simple argument tutorials and explicit statements of goal criteria (e.g., include other side information and elaboration of supporting reasons) in the task instructions.

TABLE 13.4. *Instructional Suggestions for Supports and Material Sets to Aid Students in Creating a Task Model and a Documents Model*

Representations and processes	Supports (tasks, instructions, environment)	Materials
Task model		
A. Creating task goals, action plans, and criteria	1. Instructions providing knowledge of discourse schema 2. Instructions providing knowledge of discipline-specific standards of evidence 3. Provide prompts to encourage creation of discipline-appropriate goals, subgoals, and standards	Not applicable
B. Monitoring progress	1. Tools for tracking substates 2. Instructions or reminders to track	Not applicable
Documents model		
A. Intertext model (document nodes and links)	1. Instructions providing knowledge of source features 2. Providing feedback on these skills 3. Provide structured input devices (e.g., forms, cards, scales) to encourage or support attention to and evaluation of these features and to encourage intertext links 4. Tools for externally representing and evaluating intra-document relationships (e.g., using comparison windows) 5. Instructions supporting development of epistemic beliefs	6. Location, availability, completeness, salience, and explicitness of source information 7. Semantic richness of source information 8. Relationship among documents in the set 9. Providing conflicting content 10. Selecting documents that cite other documents within the set
B. Mental model integration (content and organization)	1. Instructions providing knowledge of discourse schema, especially for argument structure 2. Provide instructions to integrate 3. Use tasks that lead to a more coherent representation of individual texts and that require integration 4. Provide tools to aid integration (e.g., multiple windows)	5. High semantic overlap in document set 6. Meaningful ordering of documents 7. The relationship among documents in the set

2. One special challenge in using argument prompts to help students learn in a discipline is that they must also learn discipline-specific standards of evidence. In fact, students appear to have special difficulty with scientific arguments (e.g. Duschl & Osborne, 2002; Kelly, Druker, & Chen, 1998; Kuhn, 1993; Osborne, Erduran, & Simon, 2004; Takao & Kelly, 2003). Therefore, students may need instructions to increase their knowledge of discipline standards of evidence.
3. For some types of argument tasks, students' interpersonal argumentation habits may interfere with the task goals. For example, it may seem more engaging for students to work on policy prompts such as making recommendations to one's friend or school. We have found, however, that even college students respond to such prompts by merely writing their own opinion, with minimal reference to provided documents. With such policy prompts it may be especially challenging for students to set up the appropriate subgoals; they may require additional instructions or criteria to be provided with the prompt to help them understand the requirement of using evidence to support their position. In general, it is best to avoid presenting policy (e.g., should), or recommendation prompts, or asking for personal opinions. A too-general prompt (e.g., find out about) will also be very demanding to students in creating discipline-appropriate goals and subgoals. More helpful prompts for creating a discipline-appropriate task model would be to focus on causal terms (e.g., what was the primary cause), or provide directions to include evidence (e.g., provide evidence to support your position) or hints in that direction (e.g., to what extent was X responsible), and include hints to disciplinary criteria (e.g., take the role of a historian and develop an argument).

It is beyond the scope of this chapter to give a complete review of the literature on teaching argument schemas to children and adults. The point we make here is that our research shows that even college students cannot be expected to correctly interpret argument prompts. For instance, many students do not include other-side information in their argumentative essays (Wolfe et al., 2009). When presenting students with tasks that require the use of an argument schema to comprehend documents and to organize the mental model, supports have to be provided to help students better understand what an argument schema is, in general, and how it applies specifically to the focal discipline.

We do not consider materials relevant in the task model section because in focusing on creating a task model, the only materials students will have

are the assigned prompt (i.e., task statement) and directions for approaching the task. To separate out the task model creation phase, we do not consider interactions with materials. Of course, this may have to be considered for students who jump right into reading without creating a task model first. But cases in which students do not initially build a task model are beyond the scope of this chapter.

Monitoring progress. The three decision-making processes described earlier require students to have the skills and knowledge needed to regulate their behavior, such as comparing various states of representation (i.e., task model, documents model, and prior knowledge) to each other or to the task product. This is not a trivial task, but rather one that gets more difficult as the demands of the task or document set become more demanding. In particular, consider two types of support for self-monitoring:

1. Students may be helped in this monitoring process by tools or supports for tracking progress through the substates in their task model. These can include highlighting, notes, annotations, concept maps, diagrams of processes, or outlines. The importance of such external memory supports may be most important in more demanding situations such as when working with difficult or new concepts, when working with new types of materials (e.g., legal documents), or with younger students who have more difficulty with self-regulation.
2. Simple instructions or reminders for students to check their progress, especially at key decision points, may also prove helpful.

Documents Model

Several aspects of the external and internal resources will affect the search for relevant information and the creation and updating of a documents model. To support students' development of these multiple-document skills, several labs have developed Web-based interventions (Britt & Aglinskas, 2002; Britt, Perfetti, Van Dyke, & Gabrys, 2000; Britt et al., 2004; Stadtler & Bromme, 2008; Wiley et al., 2009), with promising results. For instance, high-school students using the Sourcer's Apprentice not only improved their ability to identify and evaluate source information, but also wrote essays on the assigned controversy that were more integrated, cited more sources, and referenced more information from primary and secondary sources than did a comparison group who did not use it (Britt & Aglinskas, 2002). Likewise, students using the SEEK tutor for science texts not only improved in source evaluation, but also learned the concepts better (Wiley et al., 2009).

Creating an intertext model: Document nodes and links. As previously noted, high school and college students generally do not spontaneously seek

out source information and do not consistently attend to critical source features when learning from multiple documents. Not only do students need to attend to and represent source information; for quality learning, this skill may involve applying discipline-specific standards for evaluating those source features.

1. Given that educators cannot assume that students will have received source evaluation training, one obvious support is to provide such instruction. For example, the two previously mentioned computer-based environments provide instruction and practice at detecting and evaluating source features in history (e.g., the Sourcer's Apprentice) and science (SEEK).
2. In addition to providing instruction, we have found that individualized feedback was also helpful during practice. In one study, we had two groups of college students use the Sourcer's Apprentice with a document set. One group then went on to use an automatic essay analyzer – *SAIF* (*Sourcer's Apprentice Intelligent Feedback*) (Britt et al., 2004) – whereas another group received general instructions to revise, and a third group received a reminder to cite sources. SAIF provided immediate feedback on students' essays on several dimensions: number of sources cited, number and type of documents covered, plagiarism, and unsourced quotations. We found that students who used SAIF produced better essays in terms of number of explicit citations, compared to simple instructions to revise or a reminder to cite sources. This improvement is noteworthy, because even the control conditions also received the Sourcer's Apprentice training. Thus, to the extent possible, individualized feedback should be given to improve the effectiveness of any explicit instruction.
3. The teacher or environment can also include structured input devices to encourage or support attention to and evaluation of source features. For instance, the Sourcer's Apprentice includes structured note cards for filling in source features, SEEK uses structured forms, and met.a.ware (Stadtler & Bromme, 2008) also uses rating scales (see a detailed discussion later in the chapter). Similarly, structured input devices can be used to encourage the creation of intertext links.
4. Students can also be provided with tools for externally representing and evaluating intra-document relationships. For instance, the Sourcer's Apprentice uses two windows to support corroboration. Students can simultaneously compare two contrasting documents and notice where documents agree and disagree. In the case of historical issues such as the Panama revolution, this should support the creation of intertext

links such as "Roosevelt and Bunau-Varilla disagree about whether Roosevelt committed support to the revolutionaries."

5. Learning the standards within a discipline cannot be completely separated from one's beliefs about knowledge. To appropriately learn from multiple documents, students have to move beyond thinking of texts as vehicles for fact learning and gain an understanding of the social nature of texts (Beck, McKeown, Sandora, Kucan, & Worthy, 1996). On the one hand, students need to be able to comprehend the structure of an author's text, but on the other hand, they cannot rely completely on the author-driven organization to learn about a topic. Students need to be aware that authors may present the events and causes in a biased way, and that they should not rely too heavily on a single author's interpretation of the events (Britt et al., 1999). Given the inescapability of uncertainty and conflict in learning from multiple documents, one's epistemic beliefs will also affect deep learning. Hofer and Pintrich (1997) classified beliefs about knowledge according to agreement with statements about how certain (absolute versus tentative) and how simple (isolated facts versus highly related and organized) the information is. They classified beliefs about the process of knowing according to agreement with statements about the source of knowledge (transmitted from authority versus self-constructed) and justification for knowing (personal experience versus rules of inquiry). Recent research has begun to connect students' epistemic beliefs with their deep learning from multiple documents (Bråten, Strømsø, & Samuelstuen, 2008; Pieschl, Stahl, & Bromme, 2008; Strømsø, Bråten, & Samuelstuen, 2008; Strømsø & Bråten, 2009). Bråten and Strømsø (2006) found that students who held more naïve epistemic beliefs (as measured by such scales) acquired more knowledge from a single, already integrated text than from the same material presented as multiple documents (at least for material that required a deeper level of understanding). For a more complete review of how epistemic beliefs may be incorporated into a framework for multiple-text comprehension and integration, see Bråten, Britt, Strømsø, and Rouet (2011). Although conclusions from this research are limited by the correlational nature of the research, it suggests that supports designed to address students' epistemic beliefs may aid students in their construction of a documents model.

Epistemological beliefs are especially important when students are asked to evaluate either the reliability of sources or whether evidence supports a claim. For example, when evaluating sources, students may start out not realizing

that documents can vary in terms of reliability or trustworthiness. Then they may either decide that nothing is reliable (it is all just opinions anyway), or they may create simple criteria such as believing a particular feature makes the document credible. Two typical evaluations from college students are "there are many credible sources: doctors and scientists.... This raises the credibility because they know what they're talking about and they have been educated in this subject" (Brem, Russell, & Weems, 2001, p. 204) and "College text would not print false facts" (Britt & Aglinskas, 2002, p. 488). In contrast, experts are aware of the inevitable effect of perspective on a document's content. As Wineburg (1991, p. 84) put it "The question put by the historian to the source was not 'Is the source biased?' but '*How* does a source's bias influence the quality of its report?'" Thus, for quality learning from multiple documents, students have to develop epistemic awareness and a more subtle understanding of reliability and trustworthiness. It is not that historians judge trustworthy documents and then reject those that do not meet a criterion. Instead they use their understanding of the author's biases to interpret the meaning of a document. Helping students not simply reject or completely accept document content based on reliability or trustworthy evaluations will undoubtedly be a challenge, but it is a necessary challenge in the twenty-first century.

In addition to a supportive environment, characteristics of the materials will also matter (see the right column of Table 13.4).

6. The location, availability, completeness, and salience of source information may all affect students' attention to and use of source information. For instance, Wineburg (1991) presented his sources at the end of the document whereas Rouet et al. (1996) presented them at the beginning as a means of selecting the document. Wineburg reported less spontaneous sourcing than Rouet et al., and on some occasions the students were actually surprised when they eventually discovered the source of the document. Thus, to help students construct document nodes and be able to have source information available to later interpret content, students may need to either be taught to start with the source (e.g., Sourcer's Apprentice), or otherwise be provided with materials that present source information prior to a document's content. This is especially true for situations where one may require knowledge and effort to locate source information. Source information is frequently missing or depleted on many Web pages (Britt & Gabrys, 2002), forcing students to seek out such information. To support students' construction of document nodes, the Sourcer's Apprentice included a short

experimenter-written description of the author and document in much the same way as "about the author" information on a book cover or an excerpt from *Contemporary Authors*. Thus, students were provided with bottom-up support for creating a rather complete source representation. Of course, as students progress, they can be taught to seek out such information on their own.

7. The semantic richness of source information may also assist students by providing a more elaborated document node with more features filled in. Kim and Millis (2006) used nondistinctive source names and found that students did not remember the source of specific content even when instructed to do so. Providing more elaborated and meaningful source information should lead to a better-quality representation of the source and thereby increase the availability of the source in memory. This may enable students to later use this information more readily when interpreting content or making connections between sources.
8. The relationship among documents in the set should also affect the creation of an intertext model. For instance, Rouet et al. (1996) found that providing primary documents increased students' attention to source information, affected their judgments of trustworthiness, and made them more likely to include references to documents in their essays as compared with students performing the same tasks without primary documents.
9. A special case to consider with document relationship is that of including conflicting content. We have found that providing conflicting content increases students' attention to source information. Rouet et al. (2009) found that discrepant information makes sources (who said what) more memorable. Furthermore, upon reading discrepant information, readers look back more at the initial source information as compared to reading consistent information (Braasch, Rouet, Britt, Knutsen, Le Bigot, & Vibert, 2010).
10. Finally, selecting documents that cite other documents within the set may help encourage students to make cross-document connections. In the document sets we created for our studies with historical controversies (Britt & Aglinskas, 2002; Rouet et al., 1996), half of the primary documents were directly mentioned and interpreted by a secondary source. Thus, the materials set made some of the intertext links explicit.

Creating an integrated mental model. According to our definition of quality learning, students not only have to integrate information; they also have to

organize the combined content into an argument or explanation. This presents a challenge because, as mentioned previously, students have difficulty comprehending, evaluating, and writing arguments. Thus, we cannot always assume that students will be able to create an appropriate integrated mental model organized around conflicting claims. Through instruction and the composition of the materials set, however, we can influence students' ability to create a quality representation from multiple documents. The following numbered paragraphs correspond to the two bottom cells of Table 13.4.

1. Students can be given instruction about how arguments are structured. Students may need to be taught how to identify an author's main claim, how to critique the quality of presented evidence, and when to include other-side information in one's own argumentative essay. *CASE* (Cultivating Argument Skills Efficiently) is a recently developed intervention to provide instruction and practice in argumentation. It has been shown to be effective at helping students develop the skills of comprehending (Larson et al., 2004), evaluating (Larson et al., 2009), and producing (Wolfe et al., 2009) arguments. An addition to direct instruction, self-explanation prompts have also been shown to be effective (worked examples: Schworm & Renkl, 2007). Both of these instructional interventions are limited at present because they provide general instruction instead of tailoring the instruction to a particular discipline. It is unclear how much the CASE modules would have to be modified to help students apply what they learn about argument to history or science controversies.
2. For students who know how to appropriately organize the information, there are many supports that can increase their propensity to do so. For instance, the simplest intervention that has been shown to help is direct task instructions. Britt and Sommer (2004) found that simply telling students to try to integrate the information from texts increased the extent to which they formed an integrated representation. In this case, students were not spontaneously integrating to the extent that they were capable and a prompt to do so was effective.
3. The type of task has also been shown to affect integration across multiple documents. Tasks that lead to a more coherent representation of individual texts are also effective in helping students create a more integrated representation of multiple texts. For instance, Britt and Sommer (2004) had students read two related texts. After reading the first text, half of the students completed a task that required them write a three- to four-sentence summary of the first text (Experiment 1) or

answer macro-level questions about it (Experiment 2) prior to reading the second, to-be-integrated, text. They found that both of these tasks improved content integration, compared to control conditions. They argued that these tasks function to strengthen their representation of the important information of the initial text so that it is more easily activated later, through simple memory mechanisms.

A task that requires the construction of an argument may also lead to a more integrated model of the situation or phenomena. For example, Wiley and Voss (1999) found that an argument-writing task led to more transformations and better learning from multiple documents, at least when given primary documents (see also Le Bigot & Rouet, 2007). However, this task may interact with knowledge level of the student. Gil, Bråten, Vidal-Abarca, and Strømsø (2010) gave participants a set of secondary documents that presented arguments addressing a controversy. They found that the argument task led to more content learning and integration only for the high-knowledge participants. In this study, knowledge was primarily determined by providing a pre-lecture. This finding reinforces the suggestion of providing an overview to ensure minimal knowledge level (see point 6 later in the chapter). This difference in findings for the argument task could also be owing to differences in the level of argumentation skills across the populations as Gil and colleagues argued, which would point to teaching argumentation skills when using this type of task (see point 1 under creating task goals, action plans, and criteria). We suspect, however, that U.S. students are no less skilled in argument than students trained in Spain. A more likely reason for the difference in findings could be either differences in the prompt (e.g., "Take the role of historian and develop an argument …" and "Write a one-page argument based on this set of texts …" versus "Express and justify your personal opinion about … Base your report on information included in the following five texts …") (see point 3 under creating task goals, action plans, and criteria) or the nature of the documents (i.e., primary versus secondary documents) (see point 7 later in the chapter).

Overall, we expect that the benefits of a task may vary as a function of the types of materials and the skill level of the students. Using a challenging task with more supportive materials may work better for students early in the development of their document skills, whereas more advanced students may benefit more from challenging materials that require more transformation.

4. Providing tools, such as multiple windows, may also help students integrate information, as long as they are encouraged to use the tools. The Sourcer's Apprentice provided students with two windows on the

screen to allow side-by-side comparison. Wiley (2001) directly compared learning from primary history documents in single-window versus two-window environments. She also gave students either an argument task or narrative task. She found that the two-window argument task led to the most integrated essays as measured by the number of transformed sentences.

Characteristics of the materials can also make the learning situation more or less challenging to form an integrated mental model from multiple texts.

5. A document set that includes texts that overlap semantically in terms of concepts and even at the lexical level will be more easily integrated than a set that requires students to make knowledge-rich inferences. Such support is most important when the materials are difficult in terms of comprehensibility or vocabulary, when students have low knowledge, low working memory, or are less skilled in creating a documents model. Recent studies have found that content will be more highly integrated when the information across documents overlaps linguistically (Kurby et al., 2005) or on multiple situational dimensions (Kim & Millis, 2006).
6. The materials should also provide a significant degree of elaboration on important information that needs to be integrated. One way to accomplish this would be to control the order of reading so that students begin with a document that provides an overview. Although it may be nice to allow students to freely select the order of documents to read, it may not be optimal for learning, especially for low-knowledge students. In fact, the material sets for both the Sourcer's Apprentice (Britt & Aglinskas, 2002) and Rouet et al. (1996) each began with a textbook overview, and the other documents were ordered from secondary to primary within each perspective on the controversy. This type of text ordering allows students to gain the necessary background knowledge to support reactivation when interpreting the remaining documents. One thing to note about order of presentation is that students often select documents in the order presented. For example, Britt, Rouet, and Perfetti (1996) found that even when told to select and read documents in a "wise" order, students frequently selected documents in the order presented from top to bottom on the screen. This was especially true when the document set was varied in terms of types of documents.
7. The relationships among documents in a set may also affect integration. At the most challenging extreme, Wiley and Voss (1999) presented

document sets with only primary documents similar to a DBQ (document-based question in Advanced Placement history classes). Wineburg (1991), Rouet et al. (1996), Britt et al. (1999), and Le Bigot and Rouet (2007) presented primary documents but also included secondary documents or textbook excerpts to provide some scaffolding of the interpretation of these more challenging documents. The least challenging material set would be a set containing all secondary documents that directly address the controversy, so that all students have to do is select the interpretation and predigested support for that interpretation. Secondary-source documents can be used to scaffold students' reading of primary documents but will not lead to as much transformation.

Asking students to read a diverse document set places special demands on the students. For instance, students have to be skilled at comprehending and evaluating documents that present data (e.g., treaties, scientific reports, witness accounts) and secondary documents that interpret data (e.g., books and book chapters). The situation is further complicated in that the type and structure of these documents will differ across disciplines. While including secondary documents that help students interpret the primary documents may lead to better comprehension, it is not expected to help students meaningfully transform the content. In fact, the advantage for the argument task that Wiley and Voss (1999) found occurred for a set of primary texts but not a set of secondary texts (Gil et al., 2010). It may be helpful to use document sets with mostly secondary documents that directly address the controversy (e.g., Gil et al., 2010; Goldman, Lawless, Gomez, Braasch, MacLeod, & Manning, 2010) for either less skilled or less knowledgeable students.

The content of the primary documents within the set is also an important consideration. For example, Perfetti, Britt, and Georgi (1995) had students read large portions of two secondary sources, one per week. They included the most important primary documents mentioned in the two books. They found that when primary documents were presented as supporting documents rather than as part of the target set, students did not read them and stated that they did not need to read them because the main document told them what the primary document said.

Determining relevance. One special aspect of decision making in the MD-Trace model (Rouet & Britt, 2011) deserves special attention at this point. When reading multiple documents for such tasks, students have to search and determine whether a document or information within a document is relevant or useful. This requires specific search skills and knowledge about search

tools such as knowing what an index, table of contents, or header is and how to use them. Also, knowing about search engines and how to use synonyms or key terms to search is now an important skill. Rouet and Coutelet (2008) found that primary and middle school students have trouble searching in books because they disregard textual organizers such as tables of contents and indexes and prefer browsing through the pages. When searching online, they also tend to favor the initial items in a list and to rely on keywords from the search probe, even though the meaning of the phrase may be irrelevant (Rouet, Ros, Goumi, Macedo-Rouet, & Dinet, 2011). A simple intervention that consisted in asking students to read and comprehend a short text about the topic prior to engaging in search decreased those biases, suggesting that students have a capacity to make more informed decisions as to relevance, but that they do not always do so spontaneously. More complex interventions are also available. Met.a.ware is an intervention tool to help people, without expertise in medicine, learn about medical topics from searching the Web (Stadtler & Bromme, 2008). The tool is designed to help improve the development of metacognitive skills for evaluating and monitoring progress in answering questions that require deep understanding.

One way to make the task of learning from multiple documents less demanding is to reduce students' access to irrelevant information. Then, as students develop these search and monitoring skills on topics that they know a lot about, one can increase the challenge by either including less task-relevant material or letting them free on the Web where they will certainly find a mass of irrelevant information. Initially, at least, it may be helpful to reduce the cost of assessing a document so that students will be more willing to read and use quality information (see Segers & Verhoeven, 2009).

A final point. The suggestions for tasks, instruction, and materials presented in Table 13.4 are certainly not an exhaustive list that could be made based on the available empirical support to date. It was not possible to review all of the relevant literature, especially in argumentation and self-regulation. This list is just a start, and we hope it becomes more complete in the coming years. We definitely need more empirical work to better understand how internal resources affect quality learning from multiple documents and the types of support that may help. For instance, how does the development of perspective taking and dealing with conflict affect learning in these situations? Our hope was to make a start in this direction. We also worry that it will be difficult to compare results of studies without attention to the many factors of external and internal resources present for each study. Such a list will make it more efficient to vary only the factors of interest or test for generalizations of findings that we think are most empirically sound.

Caveats

When providing supports, care should be taken to help without eliminating critical aspects of the multiple-document learning situation. For example, students need to be able to read a variety of document types to develop a deep understanding of the content. Including secondary documents can help students interpret the primary documents that might otherwise be relatively inaccessible. If, however, a primary document is already interpreted by the secondary documents, then students might not perceive a need to read and understand the primary documents for themselves. Conversely, we have found that if the secondary documents actually address the controversy, students simply select reasons and evidence provided in these documents. In such a situation, students are not really forced to transform, integrate, or deeply understand the content. Thus, one has to be careful when presenting secondary documents and expecting students to write an argument.

Furthermore, we expect that the task of learning from multiple texts may be easier when the structure of the texts matches the task. For example, it will be easier to write an argument from texts that have an argument structure than from texts that are structured as a narrative, description, or table. Matching material and task structure may be a good method to scaffold learning for students less skilled in argumentation or less knowledgeable about the domain, but it may not lead to deeper learning for students who do not need such supports. To make the situation more challenging, the materials should not directly address the controversy. Deep learning requires students to transform and organize information differently than how it is presented in the document set.

Decisions about what supports to provide is further complicated by what Bjork calls *desirable difficulties* (Bjork & Linn, 2006). They have found, across many different situations, that the processing that leads to better, longer-lasting and generalizable gains is also more time consuming and challenging during learning. Therefore, the selection of supports must balance the challenge of the immediate learning situation and the degree to which the supports encourage transfer and sustained learning gains.

Summary

In this chapter we have reflected on what quality of learning means in situations where students have to read, understand, and make use of information from multiple documents. We have argued that these situations may be beneficial to learning, but that they also involve new challenges for students and teachers. We have outlined a framework to describe the cognitive processes and representations involved in studying multiple documents. Compared to

single-text comprehension, the processing of multiple documents elicits the social nature of knowledge production and dissemination. Furthermore, the comprehension of multiple documents can promote deeper levels of engagement and critical assessment of textual materials.

We have also provided an overview of two models aimed at describing the processes and representations that underpin the educational use of multiple documents. MD-TRACE is a process model aimed at describing the key steps and processes involved in multiple document comprehension activities. MD-TRACE emphasizes the external and cognitive resources needed for multiple document comprehension, as well as the key role of a task model. The documents model framework describes the mental structures that readers of multiple documents create to represent source information and to structure heterogeneous and possibly conflicting document information. The documents model and MD-TRACE models of document processing provide a useful framework for generating testable research questions concerning the effects of task, reader, and text variables on comprehension in multiple document learning situations. Those questions can lead to a better empirical basis for creating tasks, materials, and supports to enable students to engage in deep learning situations.

Several instructional implications can be drawn from the documents model/MD-TRACE frameworks. We have argued that tasks involving the comprehension of multiple documents should support both bottom-up and strategic processes. Supporting bottom-up processes involves emphasizing source information to facilitate the construction of an intertext model. Supporting strategic processes involves scaffolding students' evaluation and intertext integration of the materials. We have reviewed a few of the studies that have implemented effective strategies to teach multiple document comprehension at the elementary and secondary levels.

The development of curricular approaches to teach these skills, however, is still in its infancy. Instructional scientists have just begun to acknowledge the critical importance of document-level skills in a world where digital media have pervaded virtually all aspects of people's lives – whether at school, at work, or at home. More research is clearly needed to understand the development of these processes and associated meta-beliefs about knowledge and learning processes. We hope that our effort to provide an account of the processes and representations involved in comprehending multiple documents will contribute to instructional designers' development of effective teaching and learning methodologies.

In conclusion, we suggest that to achieve quality learning in content areas, students must possess advanced document skills. A mere exposure to

multiple-document and complex document-based tasks is not likely to be enough to acquire those skills. Instead, teachers need to define task contexts and objectives that will let students get familiar with text genres, sources, and organizers, and turn this knowledge into effective heuristics to access, evaluate, and integrate document information. These instructional objectives may require an extensive and patient curriculum throughout middle and high school education. However, the implementation of these goals is a key factor in preparing today's students to the challenges of the information society.

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