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DRAWING IS INTEGRATING: AN EXAMINATION OF STUDENTS' GRAPHIC REPRESENTATIONS OF MULTIPLE TEXTS

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In this study, integration, or students' connection formation across texts, was examined across two tasks: when undergraduates were asked to complete a writing assignment and a novel, diagram construction task. While the writing assignment asked students to compose an argument based on multiple texts, the diagram construction task asked students to visually represent a set of eight conflicting texts and the relations among them. The Documents Model Framework (DM) was used to code undergraduates' written responses and diagrams for the type of multiple text representations they featured (i.e., mush models, separate representations models, and documents models of multiple texts). Moreover, written responses and diagrams were coded for the specificity at which they integrated texts, corresponding to the formation of evidentiary, thematic, and contextual relations. Limited associations were found between college students' written responses and the diagrams constructed. Implications for understanding multiple text integration are discussed.

Students today are often times required to make sense of complex or controversial topics based on information presented not within a single text, but rather across multiple disparate sources of information, or to engage in multiple text use. This requires that students connect and coordinate information presented across a variety of texts in order to form a coherent understanding of a topic or issue, or engage in integration. Across studies of multiple text use, integration has been investigated in a number of ways – including as reported during students' multiple text processing (i.e., strategy use during think-

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alouds, Anmarkrud, Bråten, & Strømsø, 2014) and as reflected in the written responses that they composed (Wiley et al., 2009). An interesting finding to emerge from these analyses is that students seem to more readily integrate information during multiple texts processing than is reflected in their writing (Wolfe & Goldman, 2005). In part, this may be because students have difficulties transferring the cross-textual connections that they form during processing into a written product. This explanation is investigated in this study. Specifically, in addition to examining integration as reflected in written responses, we use a non-textual approach (i.e., asking students to construct a graphic representation of multiple texts) to gauge students' ability to form cross-textual connections or to integrate multiple texts.

Defining Integration

Theoretical models have positioned integration as key to students' learning from multiple texts (List & Alexander, 2017, 2018; Rouet & Britt, 2011). Multiple text integration may be thought of as both the process of forming novel connections across seemingly unrelated texts and the product of students' multiple texts processing, namely the formation of an interconnected representation of information presented across texts and texts themselves (List et al., 2019). Nevertheless, in this study we focus on the latter view of integration, examining the holistic representations of multiple texts that students form after reading. To understand the types of holistic representations that students form when reading multiple texts we draw on the Documents Model Framework (DM; Britt, Perfetti, Sandak, & Rouet, 1999; Perfetti, Rouet, & Britt, 1999). The Documents Model Framework suggests that students comprehend information presented across multiple texts by constructing two mental models or levels of multiple text representation: the integrated mental model and the inter-text model. The integrated mental model is a representation of the central topic or issue discussed across texts. The inter-text is a structural model, linking specific content presented within a text to information about its source of origin (e.g., author, publisher) and

representing connections across sources (e.g., as agreeing, disagreeing, or complementing one another). In understanding multiple texts, students may connect their integrated mental models and inter-text models to varying degrees of effectiveness. Specifically, students may connect these models in at least four ways, resulting in the formation of four different types of mental models of multiple texts. These are (a) mush models, (b) separate representations models, (c) documents models, and (d) tag-all models of multiple texts (Britt et al., 1999; Perfetti et al., 1999).

When students successfully construct an integrated mental model (i.e., forming a coherent understanding of a common topic or issue discussed across texts), but are unable to form an inter-text model, or link content to its source of origin, they form a *mush model* of multiple texts. While mush models are effective in integrating content presented across texts, they are limited in helping students to resolve conflicts or discrepancies, since students are not able to trace content back to its source of origin to compare texts' relative trustworthiness, due to limitations in inter-text model construction. Conversely, when students are successful in inter-text model formation but limited in integrated mental model construction, a *separate representations model* of multiple texts is formed. This model is effective in linking content to its text of origin but demonstrates limited integration of content or sources across texts.

When students are effective in both forming and linking integrated mental models and inter-text models of multiple texts, *documents models* result. Relative to mush models and separate representations models of multiple texts, these may be considered to be true instances of multiple text integration. Specifically, documents models reflect both an integrated conceptualization of a common topic or issue described across texts and a mapping of which elements of that issue were introduced by which sources. This allows important information, appearing across texts, to be emphasized at the same time that discrepant information is evaluated and, potentially reconciled, based on the relative trustworthiness of its sources of origin. Finally, a *tag-all model* is considered to be an expert version of the documents model. Like the documents model, the tag-all

model integrates content across texts, while associating particular information with its source of origin and forming connections across sources; but the tag-all model differs from the documents model in the volume of connections that are formed. In particular, it comprehensively integrates all of the content presented across all of the texts, rather than prioritizing important information and dismissing less relevant or untrustworthy content.

The Documents Model Framework (Britt et al., 1999; Perfetti et al., 1999) as a theory of multiple text integration can be thought of in parallel to theories examining students' synthesis writing based on multiple texts (i.e., reading-writing task completion, Mateos et al., 2014; Segev-Miller, 2004; Spivey, 1990; Spivey & King, 1989). Spivey (1990) identifies synthesis writing as involving the selection, organization, and connecting of information from texts in students' writing, capturing the processes likely to result in documents model construction. At the same time, while synthesis writing has focused on students' connecting of complementary or related information across texts, the Documents Model Framework explicitly considers how students may represent information that is both complementary and conflicting across texts, with the latter achieved by tying discrepant information to its source of origin and cognitively representing discrepant sources as in conflict with one another. In this study, we draw more on the Documents Model Framework as the guiding theory for our understanding of students' multiple texts integration for two primary reasons. First, while models of synthesis writing are focused on students' processing strategies during multiple text use (e.g., linear, spiral, or recursive patterns of reading and writing during composition, Solé, Miras, Castells, Espino, & Minguela, 2013), the DM conceptualizes the types of products or external representations that may result from students' engagement with multiple texts; the latter being the focus of this study. Second, while models of writing synthesis focus on students' integration of complementary texts, the Documents Model Framework discusses how students represent connections across both complementary and conflicting texts. This range of cross-textual connections, including both complementary and conflicting relations

formed, are the focus of the present investigation, asking students to read multiple texts addressing a controversial topic, the legalization of sex work.

Moreover, consistent with the Documents Model Framework, examining how students ultimately represent multiple texts in the mental models and external representations (e.g., written products) that they form, we consider not only the type of connections formed across texts (i.e., complementary or conflicting) but also their specificity. In a set of recent studies examining undergraduates' writing about the controversial topic of overpopulation, List et al., (2019) found students to connect multiple texts at three different levels of specificity, forming evidentiary, thematic, and contextual relations across texts. Evidentiary connections refer to students' corroboration of specific information across texts. Thematic connections reflect higher-order links between texts' theses or main ideas. Finally, contextual relations reflect connections formed based on meta-textual features or documents information. Rather than looking at specific content in texts, contextual connections are based on students' consideration of author characteristics (e.g., trustworthiness) or domain perspective. In this study, we examine the formation of these connections when students are asked to create a diagrammatic representation of and to write about a set of multiple, conflicting texts.

Investigations of Integration

A variety of empirical investigations have considered how students may integrate or form connections across texts. These investigations have looked to both process (e.g., think-alouds, strategy inventories) and performance (e.g., written responses) approaches to understanding integration.

Process measures. During processing, integration has commonly been assessed via think-alouds. Wolfe and Goldman (2005) examined students' think aloud utterances produced while reading two texts, providing conflicting explanations for the fall of the Roman Empire. They identified three types of cross-textual connections evidenced in sixth grade students' think-alouds comments. Surface connections were superficial

links formed based only on the semantic overlap between texts. Deeper-level connections reflected students' formation of causal or comparative links, with the latter more commonly reported.

In a more recent study, Anmarkrud, Bråten, and Strømsø (2014) found students' cross-textual utterances to reflect efforts either to (a) identify and learn important information, (b) monitor or improve comprehension, or (c) evaluate texts, with evaluative utterances found to be significantly associated with task performance. Important to note is that findings from both Wolfe and Goldman (2005) and Anmarkrud et al. (2014) indicate that students' integration-based multiple text task performance was more limited than may be suggested by the range and volume of integrative utterances reported during processing. This insight points to the need for non-composition based methods of capturing integration, when students are not hampered by writing demands. In this paper, we use a diagram construction task to investigate students' integration of multiple texts.

Performance measures. While a variety of methods may be used to tap integration performance (e.g., Bråten & Strømsø, 2011), writing has commonly been used as a means of assessment (Britt & Aglinskas, 2002; Wiley & Voss, 1999). Students' writing has been evaluated according to a variety of metrics considered to correspond to integration. These metrics include the number of citations, connectives (e.g., linking words, like because), switches (i.e., discussing Text 1, then Text 2, then Text 1 again), and transformations (i.e., statements integrating information from two or more texts) included (Britt & Aglinskas, 2002; Britt & Sommer, 2004; Kurby, Britt, & Magliano, 2005; Wiley et al., 2009). These various metrics have been considered to serve as proxies for integrated mental model or inter-text model development, as per the Documents Model framework.

Written responses have also been coded more holistically for their degree of integration (Britt & Aglinskas, 2002; Wiley et al., 2009). For instance, De La Paz and Felton (2010) scored students' history essays based on their clarity, structure (e.g., provision of an introduction and conclusion), as well as effective text-based evidence use, and integration. Integration was

reflected in essays scored as strong or as exceeding expectations when students demonstrated the ability to “analyze, compare, and contrast” issues or events presented across texts.

Present Study

To the extent that students’ written responses have been found to demonstrate limited integration (Britt & Aglinskas, 2002; Britt, Wiemer-Hastings, Larson, & Perfetti, 2004), in the present study we investigate whether asking students to represent the relations among texts using a non-writing, diagram construction task may also serve as a means of capturing integration. Diagram construction tasks and other generative activities have long been found to benefit learning, particularly in the natural sciences (Leopold & Leutner, 2012; Van Meter & Cameron, 2001). In such investigations, learners have been asked to draw external representations of information presented within a single text, with the expectation that drawing would support students’ attention to and elaboration of relevant scientific concepts and (causal) inferencing about them (Schwamborn, Mayer, Thillmann, Leopold, & Leutner, 2010; Van Meter, Aleksic, Schwartz, & Garner, 2006). For example, Gobert and Clement (1999) in a study examining students’ reading about plate tectonics instructed learners: “Thinking back to what you just read, draw a picture of the different layers of the earth. Include and label all the information about these layers that you can” (p. 42); while Scheiter, Schleinschok, and Aainsworth (2017) asked students to create sketches of the water cycle “for themselves that would help them to later reconstruct the process” (p. 872).

In this study, we thought that diagram construction may afford at least three advantages as a mechanism for capturing multiple text integration. For one, asking students to construct a diagrammatic representation of multiple texts was expected to allow learners to easily translate the inter-text and integrated mental models that they cognitively constructed into an external measure of performance. To the extent that mental models of multiple texts have been conceptualized as interconnected source nodes, we expected that students could, potentially,

more easily represent the structure of their mental models as a diagram, rather than through writing (Britt et al., 1999; Perfetti et al., 1999). Additionally, we expected a diagrammatic approach to eliciting integration to facilitate students' formation of cross-textual links. Linguistically expressing connections among texts requires students to both formulate and identify a particular relation across texts (i.e., labeling it as causal, comparative). Using a diagrammatic approach to capture integration was expected to allow students to connect texts or ideas to one another (e.g., via a line), without necessarily needing to specify a particular relationship among them.

More generally, we thought that eliminating the writing demands associated with response composition might allow students to focus more on connecting or integrating texts. Likewise, simply positioning multiple texts via a graphic representation, rather than sequentially describing them through words, was expected to foster students' connection formation. Indeed, studies of learners' search have found graphic interfaces (i.e., interfaces that explicitly show the connections among texts, for instance, grouping texts as addressing causes or solutions, like Kartoo) to be more facilitative of multiple text comprehension and integration than list-based search engine results pages (e.g., Google; Kammerer & Gerjets, 2012; Salmerón, Gil, Bråten, & Strømsø, 2010). In this study, we thought that students' ability to arrange texts in relation to one another via diagram construction could likewise support integration.

As a final point, we expected a diagrammatic approach to be particularly conducive to capturing students' integration of texts addressing an interdisciplinary topic, like the one examined in this study (i.e., legalizing sex work). Recent work categorizing the types of connections that students may form when integrating multiple texts has found students to connect texts at three levels of specificity. In particular, students have been found to integrate texts based on the specific evidence that they introduce (i.e., evidentiary integration), their main ideas or key points (i.e., thematic integration), and their authors' characteristics or disciplinary points of view (i.e., contextual integration, List et al., 2019). Examining students' written

responses, List et al., (2019) found very few instances of contextual integration to be evidenced, revealing that students experience particular challenges in identifying and linking different disciplinary perspectives across texts. This may present a unique challenge when students are asked to learn about complex, interdisciplinary topics. Such topics are characterized, in part, by a variety of domains or disciplinary perspectives being relevant to their conceptualization. To the extent that students' written responses were identified as limited in capturing contextual integration, we were particularly interested in determining whether the opportunity to graphically represent the relations across texts facilitated students' formation of contextual connections. In this study, we adopt a diagrammatic approach to understand how students form connections across multiple, interdisciplinary texts. As an added point, we examine whether cuing students to texts' positionality with respect to a controversial topic fosters contextual integration. In particular, consistent with prior work which has found the format of text presentation to have an effect on multiple text use (Le Bigot & Rouet, 2007; Salmerón et al., 2010), we manipulated text presentation by introducing students to texts either by title (e.g., Sex Workers Have a Right to Labor) or by position and title (e.g., Pro: Sex Workers Have a Right to Labor).

We have the following research questions:

1. What types of multiple text models are reflected in students' diagrams? What type of integration is evidenced?
2. What types of multiple text models are reflected in students' written responses? What type of integration is evidenced?
3. What is the association between the types of multiple text models formed when students construct diagrams of multiple texts and compose written responses based on multiple texts?

The writing and diagram tasks examined in this study may be considered to be separate means of fostering multiple text integration in learners. While the exploratory nature of this study and certain methodological decisions preclude these two tasks from being directly compared, they represent methods commonly used in prior work to foster integration (i.e., asking students to compose an argument based on multiple texts,

Bråten & Strømsø, 2009; Wiley & Voss, 1999) and a novel approach that may encourage such connection formation across texts (i.e., constructing a graphic representation of multiple texts).

Methods

Participants

Participants were 55 undergraduate students at a mid-sized university in the Midwestern United States (age: $M=21.15$, $SD=1.71$). The sample was 52.73% female ($n=29$) and 41.82% male ($n=23$). The majority of the sample identified as White (59.62%, $n=31$), with remaining students identifying as Black/African American (23.08%, $n=12$), Asian (9.62%, $n=5$), and Latino/Hispanic (5.77%, $n=3$). Three students declined to provide demographic information.

Measures

The study consisted of three primary components. First, participants were asked to complete several individual difference measures. Then, participants were asked to complete a multiple text task. This involved researching and composing a written response arguing whether or not sex work should be legalized. Finally, participants were given a diagram construction task or asked to create a visual representation of the texts provided and the relations among them. Students then wrote brief explanations of the diagrams that they constructed.

Individual difference measures. Participants were asked to complete a variety of individual difference measures, including assessments of prior attitudes and topic familiarity.

Attitudes. Attitudes were assessed both prior to and following the multiple text task.

Pre-task attitudes. The sample was fairly evenly split in terms of attitudes toward legalizing sex work, the topic of the multiple text task. Specifically, in response to the question, *do you think that prostitution/sex work should be legalized*, 30.91% ($n=17$) of the sample selected *yes, prostitution/sex work should be legal*;

40.00% ($n=22$) of the sample selected *no, prostitution/sex work should not be legal*; while 23.64% ($n=13$) of the sample selected *I'm not sure*. At pre-task, participants were also asked to rate their attitude certainty using a three item scale (e.g., how certain are you; Cronbach's $\alpha=0.91$). Mean certainty was 4.02 ($SD=0.99$), on a five point scale, indicating that students were quite confident in their initial attitudes.

Post-task attitudes. After completing the multiple text task, participants were again split in their support for legalizing sex work. Specifically, 40.00% of the sample ($n=22$) indicated that sex work should be legalized, 47.27% ($n=26$) reported that sex work should not be legalized ($n=26$), while 5.45% ($n=3$) of students selected an *other* option.

Topic familiarity. In addition to reporting their attitudes and attitude certainty, prior to the multiple text task, students were also asked to provide an initial justification for their attitude toward legalizing sex work. While a specific assessment of prior knowledge was not included in this study, students' attitude justifications were examined as a measure of their familiarity with the topic of the task. The number of relevant claims or reasons included in students' attitude justifications at pretest were used as a measure of topic familiarity. On average, students included 2.10 reasons ($SD=1.36$) in justifying their attitudes toward legalizing sex work. Two raters scored 13 student responses (23.64%), with Cronbach's alpha reliability equal to 0.92.

Students were also asked two questions to capture self-reported topic familiarity. Specifically, students were asked to endorse two items: *how much have you previously thought about this question* and *how much have you previously learned about this question*. Students' average ratings of topic familiarity were 2.90 ($SD=1.22$) on a five-point scale.

Multiple text task. The multiple text task had two primary parts, a research phase and a response phase. During the research phase, participants were asked to use a library of six digital texts to research whether or not sex work should be legalized. In the response phase, participants were asked to compose an argument justifying their point of view on this topic.

Research phase. First, participants were asked to research the prompt: *Write an argument about whether or not the U.S. should legalize prostitution/sex work*, using a library of six digital texts. Within the digital library, students were randomly assigned to one of two navigation conditions. The non-cued navigation condition presented students with library texts arranged by title (e.g., *Sex Work is a Civil Right*). The cued navigation condition introduced students to library texts according to texts' stance (i.e., pro/con or supporting or opposing sex work) and title (e.g., *Pro: Sex Work is a Civil Right*). Prior work has found that placing texts into conceptual categories (e.g., causes, solutions) has affected students' multiple text comprehension and integration (Salmerón et al., 2010; Stadtler & Bromme, 2008). Similarly, presenting texts by topic and author has been found to foster referencing or citation use during essay writing, more so than listing texts according to topic (Le Bigot & Rouet, 2007). In this study, we were interested in whether cuing texts' position as in support of or in opposition to a controversial topic would have an effect on integration.

Texts. Texts in the library presented a variety of conflicting and complementary arguments about whether or not sex work should be legalized. For instance, three of the texts argued for the legalization of sex work for reasons of public health, criminal justice, and increased economic participation. The three texts arguing against the legalization of sex work provided evidence that it increased sex trafficking, violence against women, and the marginalization of already at risk populations. Texts were drawn from the New York Times' Room for Debate segment and modified for inclusion in this study (<https://www.nytimes.com/roomfordebate/2012/04/19/is-legalized-prostitution-safer>).

All of the texts were presented as trustworthy sources (i.e., attributed to reputable authors and publishers) and were relevant to composing a response to the target task. At the same time, texts were systematically varied in at least three ways. First, while three of the texts provided evidence supporting the legalization of sex work, three of the texts opposed its legalization. Second, the texts introduced a variety of disciplinary perspectives, including economic, legal, sociological, and public health

perspectives, on legalizing sex work. Third, while some of the texts were attributed to experts providing research-based evidence on the issue of legalizing sex work, other texts adopted a first-person perspective (e.g., a former sex worker).

Texts were introduced in the library by title (i.e., non-cued navigation condition) or by stance on legalizing sex work and title (i.e., cued navigation condition). Students were randomly assigned to one of two navigation conditions. Order of text presentation was randomized for each participant. Students were free to access any number of texts in the library as well as to revisit texts, as needed.

Response phase. Next, participants were asked to compose a written response based on multiple texts. Specifically, participants were first asked to take a stance on whether the U.S. should legalize sex work. Then, they were asked to write an argument justifying their response. Students' written responses were coded based on the Documents Model Framework, for the type of multiple text models that they reflected (i.e., mush model, separate representations model, or documents model) and the type of integration they featured (i.e., evidentiary, thematic, or contextual, Authors, under review). Moreover, students' responses were scored for the number of citations that they included.

Multiple text models. Responses were coded according to the Documents Model Framework (Britt et al., 1999; Perfetti et al., 1999). Three types of models, typical of novice representations of multiple texts, were coded for: mush models, separate representations models (with and without citations), and documents models. Mush models were categorized by students' integration of information, presented across texts, but a failure of citation, or a lack of attribution of said information to sources of origin. Separate representations models reflected students successful citation or formation of source-content links but did not demonstrate any integration. These responses were characterized by students presenting information from different texts sequentially in their written responses, but not drawing any connections among them. A variation on the separate representations model with citations was the separate representations model without citations. These multiple text models separately introduced information from each text, with no connections formed

between them, but did not make explicitly reference to or cite sources in doing so. Finally, documents models reflected both students' formation of source-content links and integration of content across texts. In other words, these responses were successful not only in connecting information across texts but also in accurately attributing this information to its source(s) of origin. Based on 15 student responses (27.27%), Cohen's kappa inter-rater agreement was 0.73, indicating moderate agreement. Disagreements were resolved through discussion.

Type of integration. Students' written responses were coded for each instance of integration featured (List, Du, Wang, & Lee, 2019). Instances of integration were coded for their degree of specificity. Evidentiary integration occurred when specific information was corroborated or linked across texts. Thematic integration reflected the connecting of main ideas or central claims across texts. Finally, contextual integration included connections drawn based on meta-textual features, like author reliability or disciplinary perspective. In addition to receiving scores for the degree of evidentiary, thematic, and contextual integration featured in their written response, students also received an overall score for the total number of integrative statements included. Based on 22 student responses (20.00%), Cronbach's alpha inter-rater reliability was 0.95, indicating excellent agreement.

Citations. Citations referred to each instance of students' explicit, nonconsecutive referencing of texts included in the digital library, either by title (e.g., Sex Workers Have a Right to Labor) or by author (e.g., Dr. Brents). Based on 20.00% student responses ($n=11$), exact agreement for the number of citations identified was 92.59%.

Diagrammatic construction task. After composing a written response, students were asked to complete a diagram construction task. This asked students to construct a visual or diagrammatic representation of eight texts presenting different points of view on legalizing sex work and the connections among them (see [Figure 1](#)).

Diagram task procedures. For the diagram construction task, students were presented with a manila folder including eight texts, arranged in a random order, and presented on different

Texts. Students were again presented with a set of eight texts introducing different points of view on whether or not sex work should be legalized. These were the same six texts as students were initially presented with in the digital library, with an additional two texts included. While students were not required to access or read all six texts presented in the digital library during the multiple text task, students were asked to read all eight texts for the diagram construction task. As was the case for the multiple text task, texts varied in their stances toward legalizing sex work, in the disciplinary perspectives that they adopted, and in presenting expert or first-person perspectives on the target issue. Moreover, while each of the six texts initially included in the digital library presented research-based evidence for or against the legalization of sex work, the two additional texts introduced as a part of the diagram construction task were more analytic in nature, presenting feminist and moralistic arguments for and against the legalization of sex work. Two additional texts were added to the diagram task in order to complexify it, as students had the texts available to them during diagram construction. Moreover, because we expected diagram construction to have a facilitative effect on integration, we wanted to increase the challenge of this task by introducing an additional two texts for students to contend with and to represent relationally.

While the multiple text task presented students with texts digitally, for the diagram construction task each text was introduced on a separate, different colored piece of paper. Due to differences in task assignment and text presentation between the writing task and the diagram task, the integration captured via these two methods cannot be directly compared.

Diagram task. After reading all eight texts, participants were asked to: *After you're done reading, use the paper provided to create a map, diagram, or visual representation of all of the texts and how they relate to each other.* Students were instructed to include all eight texts in their representations. Moreover, after completing their diagrams, students were asked to explain why they depicted, related, and organized texts in the ways that they did. Students' descriptions were used to aid in diagram coding (see [Table 1](#)).

Students' diagrams were coded for the multiple text models they reflected and the level of integration specificity they evidenced (i.e., evidentiary, thematic, or contextual). Moreover, diagrams were categorized according to a number of dimensions found to be common across them (e.g., whether all eight texts were included, whether text evaluation was evidenced).

Multiple text models. Consistent with the multiple text models introduced in the DM framework and identified in students' written responses, diagrams were coded as reflecting mush models, separate representations models (with or without citations), or documents models of multiple texts. Mush models in

TABLE 1 Sample Diagram Explanations

| Type of Documents Model | Sample Explanation |
|--|---|
| Mush model | On my diagram I created a dome which symbolizes the umbrella term for prostitution. Sex is the main root and then pleasure, safety, profit, abuse, and various orientations of sex come from that. I linked abuse and profit together and then showed that they would not exist if regulations were in place |
| Separate representation without citation | I took facts from each article. I picked out facts that let girls know it's not okay to become a prostitute |
| Separate representation with citation | I put my texts into two separate categories; for and against legalization of prostitution/sex work. In these two categories, the ones who were in the same category displayed some of the same view points and target areas in the topic. They all had the same ideas to get across if they were in the same category |
| Document model | I first divided the papers up into categories based on the argument it makes: moral, legal, social, personal experience. As my diagram indicates it's difficult to fit each argument into a single category. The lines indicate the overlap between article categories. I then outlined the title of the article in orange or green. Orange for an argument against legalization and green for an argument for legalization. This is enable me to keep track of the points being outlined |

Note: Diagram descriptions do not correspond to diagrams included in [Figure 1](#).

diagrams were identified when learners connected information across texts, without representing its source or document of origin. Separate representations models were reflected in diagrams when students individually depicted information within particular texts without drawing any connections among them. When texts were referred to by title or author but depicted separately this was considered to correspond to a separate representations model of multiple texts, with citation; when isolated information was introduced but with no reference made to the texts it originated from, this was referred to as a separate representations model of multiple texts, without citation. Finally, documents models of multiple texts were represented in diagrams that portrayed a variety of association among texts and included explicit references to the eight sources provided. Two raters scored 24 student diagrams (43.64%), with Cohen's kappa inter-rater agreement equal to 0.69, indicating moderate agreement. Disagreements were resolved through discussion. Sample diagrams, corresponding to different models of multiple texts, are represented in [Figure 1](#). Sample diagram explanations are included in [Table 1](#).

Integration specificity. Students' diagrams were also coded for the specificity of the relations among texts they depicted (List et al., 2019). Students received a single point for every meaningful connection identified across texts at the evidentiary, thematic, or contextual levels. Meaningful connections were either those depicted in the diagrams that students constructed, those described in students' diagram explanations, or both. Cronbach's alpha inter-rater reliability, based on 24 student diagrams, was 0.80, indicating good agreement.

Componential coding. Four indices associated with diagram construction were examined. These were binary codings reflecting: (a) whether or not students included all eight texts in their diagrams, (b) whether or not students used a pro/con structure to represent the relations among texts, (c) whether or not students examined any additional themes in categorizing or connecting texts, and (d) whether or not students evaluated texts (e.g., considered author trustworthiness or bias) as a part of connection formation. For each component, Cohen's kappa inter-

rater agreement ranged from 0.75-1.00, indicating strong to almost perfect agreement (exact agreement 87.50%-100.00%).

Results

Research Question 1. Multiple Text Models in Students' Diagrams

Diagram components. Research Question 1 examined the types of models reflected in students' diagrammatic representations of multiple texts. First, we considered whether or not diagrams made explicit reference to the eight texts provided. Indeed, the majority of students' diagrams were found to do so (81.13%, $n=43$). This reflected the explicit instructions that students received to refer to all eight texts in the diagrams that they formed. Moreover, referring to texts by title or author likely facilitated diagram construction. Further, a majority of the diagrams that students constructed used a pro/con structure to represent texts (66.04%, $n=35$). In part, this may have been caused either by the navigational manipulation examined in this study (i.e., non-cued versus cued navigation) or by our deliberate selection of texts according to their support for or opposition to the legalization of sex work. Approximately half of diagrams (47.17%, $n=25$) identified some other relation between texts, beyond their pro/con structure. Finally, 24.53% ($n=13$) of representations included some indication that students had engaged in text evaluation. This included the organization of texts according to their comparative trustworthiness or the designation of texts as research-based or more personal in nature.

Due to the large proportion of students using a pro/con structure in the diagrams that they constructed and the navigation conditions examined in this study, if students *only* employed a pro/con structure in representing texts in their diagrams, these diagrams were coded as reflecting a separate representation of multiple texts (with or without citations). If additional relations among texts, beyond the use of a pro/con structure, were identified, students' diagrams were coded as reflecting a documents model of multiple texts.

Multiple text models in diagrams. Approximately, one third of the diagrams that students constructed (30.91%, $n=17$) were classified as reflecting a separate representation of multiple texts, or simply arranging texts using a pro-con structure, with no additional connections formed among them. This included 23.64% ($n=13$) of diagrams that separately represented texts with texts explicitly identified (i.e., citations) and 7.27% ($n=4$) of diagrams that separately represented texts without the use of citation. Mush models, reflecting students' formation of connections across information in texts, but with none of the eight texts explicitly referred to, constituted 9.09% ($n=5$) of the diagrams constructed. Finally, documents models, including both the representation of each of the eight texts and the identification of various integrative relations among them, were featured in 56.36% ($n=31$) of students' diagrams.

As may be expected, the four multiple text models that students represented via their diagrams differed in the total number of instances of integration identified, $F(3, 49)=8.07$, $p<0.001$, $\eta^2=0.33$. Post-hoc analyses using Tukey's HSD determined that students' diagrams depicting documents models ($M=5.90$, $SD=3.31$) included significantly more instances of integration than did students' diagrams reflecting separate representations of multiple texts, with ($M=2.08$, $SD=0.86$, $p<0.001$) and without ($M=1.50$, $SD=1.00$, $p<0.05$) citations.

Specificity of integration. The degree of integration specificity in students' diagrams was also coded for. On average, students included 4.54 ($SD=3.17$) instances of integration in the diagrams they constructed. This included students identifying evidentiary ($M=0.61$, $SD=1.56$), thematic ($M=3.24$, $SD=2.18$), and contextual ($M=0.69$, $SD=0.97$) relations across texts. In particular, while 94.55% ($n=52$) of respondents included at least one instance of thematic integration in their diagrams, only 21.82% ($n=12$) of students included representations of evidentiary integration, while 41.82% ($n=23$) of students depicted contextual integration. In part, the high proportion of thematic integration in students' diagrams may be reflective of their frequent use of a pro/con structure to relate texts. Pro/con relations, reflecting stances for or against legalizing sex work, corresponded to two instances of thematic

integration when included in students' diagrammatic depictions of multiple texts.

The type of multiple text models reflected in students' diagrams did not vary in association with navigation condition [$\chi^2(4)=2.87, p=0.58$]. Moreover, the total number of connections featured in students' diagrams did not differ by condition, $F(1, 49)=0.51, p=0.48$.

*Research Question 2. Multiple Text Models in Students'
Written Responses*

Multiple text models in written responses. The second research question examined the types of multiple text models reflected in students' written responses. The majority of students' written responses reflected a separate representations model of multiple texts, 36.36% ($n=20$). This included 23.64% ($n=13$) of student responses reflecting a separate representations structure with no citations and 12.73% ($n=7$) of responses exhibiting a separate representations model with citations. Mush models, integrating information across texts but with no explicit reference made to sources of origin, were reflected in 21.82% ($n=12$) of students' responses. Documents models were exhibited in 20.00% ($n=11$) of students' compositions. Finally, 16.36% ($n=9$) of students' written responses were placed into the other category. These were written responses that did not represent multiple texts; rather, these were responses constructed either entirely based on information presented within a single text or based on students' prior knowledge.

The four multiple text models reflected in students' written response differed in the volume of integrative statements they featured. As may be expected, written responses coded as featuring a documents model of multiple texts ($M=2.64, SD=1.12$) or a mush model ($M=1.55, SD=1.29$) included more instances of integration than did written responses coded as reflecting separate representations of multiple texts with ($M=0.00, SD=0.00$) and without ($M=0.08, SD=0.29$) citations as well as responses placed into the other ($M=0.00, SD=0.00$) category. An independent samples *t*-test determined

that students' responses categorized as reflecting documents models ($M=2.64$, $SD=1.12$) included significantly more integration than those categorized as mush models ($M=1.55$, $SD=1.29$, $p < 0.05$), $t(20)=2.12$, $p < 0.05$, $d=0.90$, indicating a large effect.

We also examined differences in the number of citations included across students' written responses. As may be expected, students constructing documents models of multiple texts ($M=5.73$, $SD=4.43$) included more citations in their written responses than did students constructing mush models ($M=0.17$, $SD=0.39$) and separate representations models with ($M=2.00$, $SD=1.00$) and without ($M=0.92$, $SD=2.18$) citations, and as compared to students whose responses were placed into the other category ($M=0.22$, $SD=0.44$). In particular, an independent samples t -test determined that students constructing documents models included significantly more citations in their written responses than students constructing separate representation models with citations, $t(11.54)=2.69$, $p < 0.05$, $d=1.16$, with degrees of freedom adjusted based on a violation of the equal variance assumption. Jointly the number of instances of integration and the number of citations included validate our coding of the types of multiple text models reflected in students' written responses.

Specificity of integration. We also examined the type of integration featured in students' compositions. On average, students included 0.96 ($SD=1.35$) instances of integration in their writing. In terms of integration specificity, responses included an average of 0.35 ($SD=0.69$) instances of evidentiary and 0.43 ($SD=0.89$) instances of thematic integration. Contextual integration was considerably more limited ($M=0.18$, $SD=0.60$) in the responses that students composed. Overall, 21.82% ($n=12$) of students included at least one instance of evidentiary integration in their writing, 23.64% ($n=13$) of students included at least one instance of thematic integration, and 9.09% ($n=5$) of students included at least one instance of contextual integration.

The type of multiple text models included in students' written responses did not differ by navigation condition, $\chi^2(4)=6.63$, $p=0.16$. Moreover, navigation condition was not

associated with differences in the total number of integrative statements included in students' writing, $F(1, 47)=0.73, p=0.34$.

Research Question 3. Correspondence between Students' Diagrammatic Representations and Written Responses Based on Multiple Texts

Our final research question examined the correspondence between the multiple text models reflected in the diagrams that students constructed and the written responses that they composed. A chi-squared test of association, comparing the multiple text models formed in response to the writing and diagram tasks, did not find a significant association between these, $\chi^2(12)=9.91, p=0.62$. Moreover, the total number of integrative statements included in students' writing was not associated with the number of connections featured in their diagrams of multiple texts, $r(48)=-0.11, p=0.47$.

Discussion

Drawing on the Documents Model Framework, this study examines the types of multiple text models that students construct when asked to compose a written response based on multiple texts and to construct a diagrammatic representation of these texts. Both the types of multiple text models that students developed and the specificity of integration that they demonstrated were captured across composition-based and diagram-based methods of examining integration. Students' written responses have been used as a predominant method for tapping integration in prior work (Anmarkrud et al., 2014; List et al., 2017; Britt & Aglinskias, 2002; List, Alexander, & Stephens, 2017; Wiley et al., 2009). In this study, in addition to examining the degree of integration featured in students' writing, we also asked students to construct diagrams, graphically representing relations across texts. We first discuss students' diagrammatic representations of multiple texts. Then we consider the integration reflected in the written responses that students composed. Third, we examine the possible overlap between the integration manifest in students' written responses

and in the diagrams that they constructed and consider why such associations may not have been identified.

Research Question 1: Diagrammatic Representation of Multiple Texts

The first research question examined the type of models reflected in students' diagrammatic representations of multiple texts. All of the novice models of multiple texts identified in the Documents Model Framework (Britt et al., 1999; Perfetti et al., 1999) and found in previous studies examining response composition (List et al., 2019) were found to be represented in the diagrams that students constructed. These included mush models, separate representations models (with and without citations), and documents models of multiple texts. Nevertheless, the proportion of the different multiple text models depicted was found to differ from earlier work examining writing (List et al., 2019). Documents models, reflected in 57% of diagrams, were found to be over-represented in the depictions that students constructed. This is an encouraging finding suggesting that, as intended, diagram construction may facilitate the formation of integrative connections across texts. Conversely, mush models and separate representations models without citations were relatively under-represented in the diagrams that students formed. This is understandable given that in creating diagrams, students' referring to texts directly, either by title or by author, likely aided in diagram construction. In fact, 80% of the diagrams constructed explicitly referred to the eight texts that students were presented with; a much higher percentage than the number of students who spontaneously cite sources when asked to compose written responses based on multiple texts (Britt & Aglinskas, 2002; List et al., 2017). Jointly, these findings suggest that diagrams facilitate both students integrated mental model and inter-text model construction. At the same time, it is important to note that even when asked to construct diagrams, a seemingly facilitative method of capturing integration, a sizable minority of students (32%) nevertheless separately represented texts, with limited connections formed among them.

In addition to differing in the overall proportion of multiple text models reflected, the specific type of integration manifest in students' diagrams also differed from patterns identified in prior work (List et al., 2019). First, more instances of integration, overall, were identified in students' diagrams than have previously been documented in students' writing (List et al., 2019). Second, the specificity of integration featured in students' diagrams was also found to differ. In particular, contextual integration seemed to be more pronounced in the diagrams that students constructed. This is key as understanding and reasoning about different disciplinary perspectives and other meta-textual features (e.g., author trustworthiness) may be key to students' understanding of complex and often times controversial, interdisciplinary topics. This finding further indicates that while at least some students have been found to be effective in contextually integrating texts, students have trouble linguistically describing these relations through writing. Indeed, prior work (List et al., 2019) found instances of contextual integration to be identified by only 2.80% ($n=4$) of students in the written responses that they composed, as compared to 34.97% ($n=50$) of students including evidentiary connections in their writing. As a contrast, instances of evidentiary integration were more limited in the diagrams that students formed. This is understandable given that students were not elaborating on the specific content or evidence presented within texts when creating their diagrammatic representations. Jointly, the prevalence of evidentiary vis-à-vis contextual integration included in students' diagrams suggests that, in addition to other benefits, diagrams may encourage students to adopt a more global approach of identifying relations across texts or to focus more on the formation of source-source links rather than on content-content (i.e., corroborative) connections.

Students' diagrams depicting the relations among multiple texts nevertheless demonstrated a number of deficits. First, some students continued to separately represent texts, even when encouraged not to do so via the diagram construction task. Second, the degree of integration manifest in students' diagrams was far from the total number of connections apparent and able to be identified across texts. Third, texts were

evaluated by only a minority (25%) of learners. Collectively, these features suggest that even while diagrams may facilitate integration, more work is needed to help students better relate texts to one another.

*Research Question 2: Multiple Text Models in Students'
Written Responses*

Although the potential for direct comparisons to diagrams is impossible due to differences in task construction and order effects, students' written responses seemed to demonstrate a paucity of integration. To start, a limited number of documents models were reflected in the written responses that students composed. Moreover, the total volume of integration included in students' writing was limited and, consistent with prior work (List et al., 2019), contextual integration was rare. These limitations in integration are perhaps best reflected in the 18% of students who were unable to compose written responses based on multiple texts, at all.

Nevertheless, ways to develop students' integration in writing may be identified by examining the diagrams that students constructed. First, a substantial majority of students (66%) adopted a pro/con structure in depicting texts. This was expected as texts were explicitly selected for study inclusions, in part, according to their support for or opposition to the legalization of sex work. At the same time, despite being quite prominent in the diagrams that students constructed, the use of a pro/con structure to relate texts to one another, or even the recognition of conflicting points of view on the topic of legalizing sex work, was decidedly missing from the written responses that students composed. This suggests that students may benefit from more instruction in how to write about multiple texts using common relational formats (e.g., pro/con, problem/solution, and cause/effect). Second, in constructing diagrams of multiple texts, almost a quarter of students demonstrated explicit text evaluation. As was the case with contextual relations more generally, evidence of text evaluation was more limited in the written responses that students composed. This may be because students experienced difficulties with verbally

describing the relative trustworthiness of various texts or because students simply dismissed texts that they deemed to be untrustworthy or biased, in the responses that they composed. Either way, students seem to need more support to describe contextual and evaluative relations in their writing.

Research Question 3: Diagrammatic and Written Representations of Multiple Texts

The third research question examined the correspondence between the multiple text models reflected in the diagrams that students constructed and in the written responses that they composed. Unexpectedly, there were limited associations between these. This may have been the case for at least three reasons.

First, written response composition and diagram construction were motivated by two different task assignments. When asked to compose a written response, students were tasked with crafting an argument based on multiple texts; when asked to construct a diagram or visual representation of multiple texts, students were explicitly instructed to represent all eight of the texts that they were provided with and the relations among them. Although argument tasks have been found to facilitate integration in prior work (Bråten & Strømsø, 2009; Wiley & Voss, 1999), this integration was likely still more limited than when students were explicitly instructed to connect all of the texts that they were presented with. In particular, asking students to compose an argument based on multiple texts may have resulted in students' formation of links between the arguments or central claims that they were putting forward and information in texts, more so than between the texts themselves.

Second, the two tasks differed in a number of ways that may have variably facilitated integration. To start, while the multiple text task allowed students to access and use as few or as many of the six library texts as they wanted, the diagram construction task required that students integrate all eight of the target texts. Additionally, the diagram task used an expanded set of texts (i.e., eight), as compared to the multiple text task

which asked students to draw only on the six library texts provided. As a final point, a critical distinction between these two tasks, potentially responsible for the differences in integration manifest, was that while students had all eight texts available during diagram construction, students did not have library texts available during written response composition. All of these factors mean that the writing and diagram-based integration tasks cannot be directly compared.

Third, statistical reasons may have contributed to the lack of an association between the multiple text models depicted in the diagrams that students constructed and in the written responses that they composed. First, substantive differences in the relative prevalence of multiple text models across diagrams and written responses likely resulted in a lack of a significant association. This may have further been exacerbated by the volume of “other” models reflected in students’ writing but not in the diagrams that they constructed. Likewise, the limited degree of integration manifest, overall, may further have contributed to the lack of an association between these two task formats.

All told, this study contributes to the literature on multiple text integration in at least three ways. First, it identifies a promising method for capturing students’ integration of multiple texts – diagram construction. In particular, asking students to construct diagrams representing the relations across texts was associated with a greater number of documents models depicted, more instances of overall integration identified, and a greater prevalence of contextual integration, than has previously been demonstrated in students’ writing. These findings suggest that diagram construction may serve as an intervention to improve the integration demonstrated in students’ writing. Second, this study further catalogs the variety of integrative connections (i.e., evidentiary, thematic, and contextual) that students are able to construct when reasoning about multiple texts. Third, it points to specific deficits in students’ writing based on multiple texts. These include deficits not only in the volume of connections that students are able to produce but also limitations in the types of integration, across texts, that students are and are not able to successfully write about.

These contributions to the literature parallel the possible instructional implications derived from this study. First, findings suggest that diagrams may be a promising technique that teachers can use either to assess students' multiple text comprehension and integration or to support students' writing about multiple texts. Second, the levels of integration specificity identified in this study suggest instructional prompts that may be used to foster students connection formation at the evidentiary, thematic, and contextual levels. Third, this study highlights the needs for students' processing of multiple texts to be examined and evaluated in a variety of ways. Finally, and perhaps most fundamentally, the range of higher-order reasoning processes that students demonstrated in response to the tasks examined in this study, including engaging in evaluation, comparison and contrast, and integration, point to the importance of including multiple text tasks as a routine part of classroom instruction.

Limitations

Despite the strengths of this study, a number of limitations must be acknowledged. First, this study utilized a within-subjects design, asking students to first compose a written response based on multiple texts and then to diagrammatically represent the relations among these. This may have contributed to an order effect and limited the robustness of findings. Students' rereading of texts for diagram construction, after initially being presented with these same texts to support written response composition, may have resulted in several confounds or differences in how students read texts initially vis-à-vis rereading texts for diagram construction. For instance, prior to diagram construction students may have chosen to focus more or to spend longer on those texts that they already found to be worthy of inclusion when composing their written responses or that agreed with their opinions on the issue. Alternately, students may have distributed their attention, focusing instead on texts that they previously considered only to a limited extent in the written responses that they composed. Students who were more metacognitively aware may have elected to focus on texts that they found to be particularly difficult during initial reading.

Finally, students may have focused on the two new texts that were introduced during the diagram construction task, rather than on the six texts that were available to them during written response composition. While we thought to somewhat mitigate these confounds by explicitly asking students to include all eight texts in the diagrams that they constructed, further work would benefit from randomly assigning students either to diagram construction or to response composition conditions or from potentially using diagrams as an intervention to improve the quality of students' writing based on multiple texts.

Second, the response composition task differed from the diagram construction task in a number of ways, including in task assignment, in the number of texts that students were asked to integrate, and in whether or not texts were made available to students during task completion. All of these factors limit the comparisons that we are able to draw between writing and diagram construction as measures of integration. In particular, adding two texts for students to represent in the diagrams that they constructed likely changed the type of multiple text models that students developed when composing written responses vis-à-vis constructing graphic representations. For one, the addition of two texts increased the number of texts and connections that students needed to represent in their diagrams. For another, because the texts introduced were analytic in nature, students would have needed to compare the logic-based evidence forwarded in these texts to the quantitative or statistical evidence presented in the initial library texts. Finally, in creating their diagrams students may have chosen to disproportionately attend to or dismiss the two novel texts introduced. More generally, the multiple text representations that students depicted in their diagrams were likely influenced by the written responses that they initially composed.

As a final point, recognizing integration in students' diagrams required some interpretation on the part of researchers, more so than did the identification of cross-textual connections in students' writing. Employing more process based measures of integration, including think-alouds and eye tracking, may serve to validate the appropriateness of researchers' interpretations of students' diagrams in future work.

Conclusion

The fundamental question driving this study was whether students are able to integrate texts successfully and just unable to articulate this integration in their written responses or whether students' integration was simply limited, overall. Both of these explanations seem to co-exist. On the one hand, asking students to construct diagrams of multiple texts appears to be a fruitful avenue for stimulating integration, particularly as far as documents model construction and contextual integration are concerned. On the other hand, even the diagrams that students constructed were limited in the volume of integration that they manifest, with texts still conceptualized as largely separate from one another. To the extent that integrating multiple texts and describing this integration through writing remains a critical competency for today's learners, this study demonstrates both the need to develop this competency further and that diagram construction constitutes a promising avenue for doing so.

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Appendix. Directions sheet for diagram construction task

This folder contains:

1. 8 texts on the topic of whether or not we should legalize prostitution/sex work
2. A piece of **paper** to diagram on

Directions:

1. Please **read** these texts carefully (you can read them **in any order you want**).
2. Please feel free to take notes on the texts.
3. After you're done reading, use the paper provided to create a **map, diagram or a visual representation** of all of the texts and how they **relate** to each other.
 - a. Please include **all eight texts**.
 - b. You may refer to the texts in any way you want.
 - c. **You may use any words, images or symbols you want**
 - d. Please make sure the **relationships you identify are clear**.
 - e. You may use the pens and markers provided

Your diagram will be used to help teachers plan curricula for high school students about this topic.

When you're done, please return to the online survey.