

Fall 12-2020

Concept Maps as Sites of Rhetorical Invention: Teaching the Creative Act of Synthesis as a Cognitive Process

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**CONCEPT MAPS AS SITES OF RHETORICAL INVENTION: TEACHING
THE CREATIVE ACT OF SYNTHESIS AS A COGNITIVE PROCESS**

by

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A Dissertation Submitted to the Faculty of
Old Dominion University in Partial Fulfillment of the
Requirements for the Degree of

DOCTOR OF PHILOSOPHY

ENGLISH

OLD DOMINION UNIVERSITY
December 2020

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ABSTRACT

CONCEPT MAPS AS SITES OF RHETORICAL INVENTION: TEACHING THE CREATIVE ACT OF SYNTHESIS AS A COGNITIVE PROCESS

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Synthesis is one of the most cognitively demanding practices novice writers must undertake, and research demonstrates that first-year students' synthesis writing practices result in more knowledge *telling* rather than knowledge creation and transforming. Pedagogies used to teach synthesis often focus on developing text-building strategies but lack explicit instruction on the more cognitively demanding *conceptualizing behavior*. To explore alternative pedagogies and heuristics, this study looks beyond composition scholarship to incorporate studies in neuroeducation and rhetoric to define synthesis as an ongoing, *generative* act of cognitive *invention*, effectively shifting pedagogical focus from text-centered product to student-centered cognitive *processes* that inform development of synthesized texts (a *product*). The methods were designed to explore any effects a visual intervention might have on developing student conceptual awareness and reflective practice over time, and whether that transferred into a final researched essay as knowledge transforming.

This small-scale exploratory study applies a mixed-methods, design-based methodology to a semester-long intervention in first-year writing classrooms using digital concept maps (DCMAPs) as an ongoing, student-designed space of visualized concept construction. A Control group applied traditional reading-to-write text-based synthesis instruction and practice, while the Intervention group used DCMAPs to enact a prolonged, visualized and reflective practice of active construction of associations, relationships, and structural knowledge building. The

DCMAP platform affordances positioned students as knowledge *designers* enacting creative / constructive processes, an approach based on neuroscience research on patterning and visualization. Intervention data includes reflective journals, narrated mapping process reflections, digital concept map images and construction processes, and a final researched essay that required synthesis of source ideas. Because of the exploratory nature of the study, results are not framed as cause-effect but as correlational possibilities that suggest inventional *acts* of visually creating connections and labeling them using rhetorically-based associational concepts lead to generative learning behaviors. Results suggest a number of possibilities for future iterations and research, as well as implications for our field's approach to the teaching of synthesis.

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This dissertation is dedicated with deep love and gratitude to my family. To my husband Shawn, who watched me pursue my “hobby” with loving patience and the unerring ability to help me remember what was *really* important. To my children, Christina and Aaron, and their spouses, who cheered me on every step of the way (even if you thought my hobby was weird). Most of all, I dedicate this work to my parents, USN Capt. (Ret.) Edward and USN Lt. (NC) Claire (Machabee) Young, who instilled in me a life-long passion for books and learning. Mom, thank you for giving me your silly sense of humor and your faith in God – without those, I would never have made it to this point in life. Dad, thank you for your endless supply of puns, love, and encouragement. To you especially, Dad, I dedicate this work. I have always wanted to follow in your footsteps, and make you proud of the legacy you passed down to me. I love you.

Finally, I humbly dedicate this work to my Heavenly Father. Thank you for always granting me the desires of my heart, even when I did not fully realize what they should be. You are truly a good, good Father.

In loving memory of Judy (Young) James...I did it, Aunt Judy!

ACKNOWLEDGMENTS

I owe so much to so many for pouring into me and this work for so many years. I am deeply grateful to my dissertation chair, Dr. Julia Romberger: your honest and insightful feedback, along with your regular “nudges” to leave out the kitchen sinks I tried to include, made this goal a reality. To Dr. Kevin DePew: you started me down this path of inquiry as one of my first professors at Old Dominion University, and your sense of humor kept me coming back for more. To Dr. Louise Wetherbee Phelps: your boundless knowledge and curiosity inspire me; I am honored to have had the opportunity to learn from you. To Dr. Elizabeth D. Woodworth: you have been my friend and my muse for so much of this journey. It has been quite the ride; I am grateful to have shared it with you.

I also want to thank the many fellow ODU students from my distance-student cohort, whose humor and unselfish sharing of their insights and knowledge enriched me and the direction of this project. I am so inspired by all of you.

Most of all, I want to acknowledge the love and sacrifices of my life-mate and best friend, Shawn, and my bright, witty children—Christina and Aaron. You are the lights of my life, the center of my heart. I am so grateful to be doing life with you.

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CHAPTER I

INTRODUCTION

Synthesis is widely acknowledged as an essential critical thinking and writing outcome for academic-level writing, referenced in composition textbooks as a desired higher-order thinking skill. It is often at the heart of deficit-focused research on college research writing abilities (see, for example, The Citation Project and Project Information Literacy). My interest in the subject emerges from my own experiences in the classroom, specifically in the research writing course at my institution's two-semester sequence of freshman writing. Like many teachers of first year writing (FYW), I routinely observe mixed results in students' writing when they are asked to synthesize researched information to support their arguments. More often than not, I see plenty of listing and summarizing, but not the sort of conceptual weaving that is characteristic of synthesis thinking and writing. It is not that we, as teachers of FYW, expect our students to arrive as experts in such higher-order critical writing practices, and we know that learning to write does not end by the conclusion of the freshman writing course sequence. As is often reported in others' scholarship (e.g., Purdy and Walker; Sommers and Saltz), "novice" academic writers struggle with the concept and practice of synthesis. Despite efforts to frame this key writing and critical thinking practice using various metaphors (remixing, conversation, combination) to inspire a more complex approach, all too often my students resort to simple summary and quote mining of sources when asked to synthesize. Instead of practicing knowledge-transforming, I see my students falling back onto the more familiar practice of knowledge-telling—simply telling information without any transformation—(Boscolo et al.

420), a result that mirrors findings¹ from The Citation Project as well as Project Information Literacy. Thus, in this area at least, the knowledge-transforming goals (developing new understanding by substantially altering the information for rhetorical purpose) of the academic research essay were often unmet by the end of semester due date (Flower; Segev-Miller). My question is why?

Synthesis Writing in Pedagogy & Practice

It should come as no surprise that a complaint often heard at institutions of higher education begins with the phrase “the problem with first-year college students’ writing skills.” This concern has appeared in various forms in academic publications (Melzer and Zemliansky; Larson; Sutton; Downs and Wardle; Lunsford and Lunsford), been the subject of professional development meetings, and has been a trending focus within disciplinary research for a number of decades—even as far back as the oft-referenced Harvard professor Adams Sherman Hill who, in 1896, observed student writers “making blunders which would disgrace a boy twelve years old” (Hesse). This view stubbornly persisted into 2016, when in *The Chronicle of Higher Education*, Joseph Teller points the finger of fault directly at our writing pedagogy, insisting that the current process approach to writing may actually overlook valuable “nuts and bolts” (presumably meaning grammar and mechanics skills) because they are associated with the current traditional theory of writing. Doug Hesse’s 2017 response to that argument offers a swift defense of the composition process classroom, yet leaves the issue of student writing struggles unresolved; rather, he simply observes that our field’s research into pedagogical practices in this area is considerable but still evolving in terms of both process and practice. However, based on a

¹ In sum, these reports conclude that the majority of students studied do not demonstrate they can understand and use material from researched sources effectively, instead using strategies like patch writing, quote mining, or writing from sentences rather than synthesis when writing research essays.

review of research in our field, this does not appear to be the case for synthesis writing pedagogies as a larger whole.

Why the gap?

Decades of scholarship in rhetoric and composition, along with writing studies, are dappled with varied theories and approaches to addressing student writing competencies in research writing, from discussions of multimedia literacies all the way to debates on the continued relevance of assigning a traditional research essay. Some scholars like Lundstrom et al. operate through an information literacy theoretical lens, defining synthesis as a “process of analyzing and evaluating information from various sources, making connections between the information found, and combining the recently acquired information with prior knowledge to create something new” (61). Others like Knoblauch argue our pedagogy reflects the textbook industry’s continued influence on how we approach argument writing (and, by extension, synthesis of source materials) (246). Many scholars describe the most common pedagogical intervention as an extension of the Reading-To-Write tradition (Flower et al. 1990; McGinley; Spivey and King). Nancy Spivey and James King describe synthesis as “an act of comprehending, in which the reader forms a mental representation from textual cues. Moreover, it is an act of composing that results in a new text to be read (or heard)” (11). Building on their work, Segev-Miller’s study of discourse synthesis writing practices of college-level writers applies an operational definition of synthesis that moves beyond a reading-writing approach and applies a more sophisticated cognitive-based framework, defining synthesis in terms of “conceptual, rhetorical, and linguistic intertextual transforming strategies” (“Cognitive” 232). Such terms of transformation and mental representation emerge from the influence of cognitive

sciences on writing theories and approaches to writing pedagogy, opening the way for my study to consider synthesis from a new angle of study: as a cognitive *process*.

There is a corresponding abundance of pedagogical resources informed by such theories for teaching the research process, including textbooks and teachers' manuals that follow a process approach to teaching research as a genre of academic writing. Yet, despite this abundance, students at all levels (including graduate level) continue to struggle with the demands of academic writing, especially when asked to incorporate and integrate source materials by synthesizing a research based academic argument. This is where my study begins, focusing specifically on the cognitive processes of knowledge transformation in synthesis writing of first-year college writers.

The Problem

As Kozminsky et al. observed in 2012, what does not appear to be widely explored in writing scholarship is *how* students think through and position their own intrinsic, preexisting knowledge in relation to source material in their efforts to synthesize, specifically as an epistemic cognitive process. More commonly, our field has explored synthesis writing as a subtask of the research assignment, often through the lens of information literacy practices, citation, and use of sources (*The Citation Project, PIL*). This focus tends to prioritize students' "correct" practices of use (i.e., of source materials and reading skills). That is, the lines of inquiry evident in these projects seem to frame student use of source knowledge from the perspective of "Guardians of Academic Discourse Conventions," measuring student intellectual engagement with sources according to these conventions and the authoritative nature of extrinsic knowledge². As a result, this approach tends to frame synthesis as a knowledge *product* to be

² Here, I use extrinsic as defined by Bizup as outside the student's own knowledge, inhabiting external texts.

assessed as text rather than a student's ongoing cognitive *process* of rhetorical and epistemological invention. As Segev-Miller observes in her study of discourse synthesis, the metacognitive processing strategies used by successful learners and writers have been left largely unexplored ("Writing" 6). Recent research in the discipline of education, however, opens interesting paths for change, including interdisciplinary research into the role of cognitive (concept) mapping as both an instructional and learning heuristic.

Pedagogical Frameworks & Synthesis

How our students learn to synthesize depends heavily on how we frame it in both theory and practice. If students struggle with this milestone of academic writing expectations, should we, as Teller suggests, look to our pedagogy, or is it the theory behind our pedagogy—specifically, how students learn? A review of scholarship in composition studies over the last several decades (since the beginning of the Process movement) seems to suggest that synthesis writing *as a process* is relatively underexplored and undertheorized. Segev-Miller acknowledges a number of synonyms are commonly used for the term synthesis, appearing in various forms such as synthesis, discourse synthesis, or writing-from-sources, which seems to suggest this academically valued skill is conceptualized and applied in a somewhat varied manner across the field. Yet it is commonly presented in textbooks, professional development articles, classroom handouts, and research studies as a universal concept and an essential college-writing skill. In one classroom handout, synthesis is defined for students as “simply a matter of making connections or putting things together” (Warwick). In another student handout for Drew University, Sandra Jamieson (one of the key researchers of The Citation Project) describes synthesis, in part, as “combining two or more summaries . . . in a meaningful way . . . to help others see the connections” (“What the Citation”). And even though Janet Emig, in her seminal

text “Writing As A Mode of Learning” defines as its goal the creation of “fresh arrangements or amalgams,” the description of how to get there is a rhetorically simple “combining or fusing [constituent parts]” (127). While these descriptions make synthesis writing sound like a relatively simple process of combining texts, it is decidedly far more complex and as difficult a concept as students will face throughout their academic careers.

How we teach synthesis in the freshman research course depends on how it is framed as a concept. The way synthesis has been addressed in available literature on the subject of teaching and learning seems thus far to be framed within what Jonassen and Reeves describe as a “traditional ‘instructivist’ pedagogy” that employs “teacher-directed, text- and workbook-dominated curriculum that has characterized educational practice for decades” (694). The variability in the way our field handles this term raises questions about its theoretical framing even before introducing and assessing synthesis practices within the classroom. Mateos and Solé observe the problematic treatment of synthesis pedagogy may be grounded in our varied approaches that appear to range from product (a writing/reading skill, a comparison and combination skill) to a process of construction. The term synthesis is variously discussed in textbooks and other teaching resource materials in terms of its place in a hierarchical sequence of learning outcomes (Bloom’s Taxonomy), a skill (how-to writing center handouts or textbook exercises), or as a product to be assessed (synthesis essay assignments), all apparently in high-valued, high-stakes situations within the context of research and research writing. In teaching materials, it is discussed in terms of metaphors of remix and assembling (Johnson-Eilola and Selber), reading-to-write strategies (Spivey), assessment, and information literacy (Lundstrom et al.). It is a topic commonly described as a “staple of academic inquiry” (Howard, Serviss, and Rodrigue 178), yet has been characterized by those few scholars who have studied it as under-

researched (Mateos and Solé 2009; Segev-Miller 2004). Despite this, those scholars who have examined student synthesis writing (Flower et al. 1990; McGinley; Spivey) all agree that “performing synthesis tasks proved too demanding . . . for most college students” (Mateos and Solé). This raises an essential challenge to our current pedagogy: how are we as instructors and scholars conceptualizing synthesis to ourselves and to our students? Is it framed as a skill-based practice or is it a creative process? What is its value to our field as a concept of inquiry and research, and how does that inform our classroom strategies? I believe one solution to these open-ended questions begins by reframing our approach to synthesis through a lens of rhetorical invention.

A Call for Change

As a teacher of first-year college writing, I find myself troubled by our field’s discourse in this area. Amidst discussions of teaching for transfer, agency³, writing about writing, and information literacy practices, I wonder at the apparent contradiction that popular teaching materials so often seem to highlight an “anti-plagiarism approach” to teach students how to *engage* with source materials while writing analytical research projects for the freshman core course sequence. Such framing, in fact, seems to limit students’ opportunities to see *engagement* with source ideas as anything more than attribution. It even privileges the way knowledge is valued as existing outside, beyond, or as already created by others, advancing knowledge

³ As used throughout this essay, the term agency is defined from a humanist-modernist lens, as explored by Steven Acardi’s chapter on Agency found in *Keywords in Writing Studies*. On page 2, he defines agency from this perspective as “something a writer can possess and use.” This definition incorporates students’ experience as well as the socio-cultural as framed by Constructivist Learning Theory, which states that students are actively engaged as agents of their own learning, rather than passive recipients. This is opposed to the post-structuralist view of agency as existing outside the individual writer, one which acts upon the writer (2-5). However, that is not to say that agency cannot be shaped by influences outside the writer, as explored in Purdy and Walker’s study on student identity as researcher. This is a key characteristic that plays an important role in my application of the term “agency” and discussion of students as designers of knowledge and epistemology.

acquisition as opposed to the types of knowledge *creation/construction* we look for in synthesis. For example, the 2014 edition of the *Bedford Handbook's* teaching manual *Working With Sources: Exercises for the Bedford Handbook* devotes $\frac{3}{4}$ of the exercises to chapters on plagiarism and citation. Such an emphasis for pedagogical practice tips the scales toward a skill-based approach over active learning. In their influential work "Writing From Sources, Writing From Sentences," Howard and Serviss call for a shift in our approach to teaching research writing, one that reorients our pedagogy away from citation skills toward "the more fundamental question of how well students understand their sources" (177). However, our practice does not yet appear to have followed through on the theory. In fact, despite our field's current trending interest in teaching for transfer, which should facilitate a closer examination of synthesis, major research projects like *The Citation Project*, *Project Information Literacy*, and *LILAC* suggest a skills-level emphasis when teaching and assessing source-based writing persists in scholarly research foci and, by extension, classroom pedagogy.

This perception of synthesis-as-skill manifests at the curricular design level as well as classroom pedagogy. An example of this may be found in the very frameworks used within higher education for curriculum and programmatic outcomes designs, like Bloom's Taxonomy, a cornerstone for educational outcomes discussions. When the Taxonomy was revised in 2001 by Anderson and Krathwohl with a view toward shifting to a more pronounced emphasis on cognitive processes as goals, the term "synthesis" disappeared and was replaced by the term *Creating*, defined as "putting elements together to form a coherent or functional whole; reorganizing elements into a new pattern or structure through generating, planning, or producing" (Anderson and Krathwohl 68). With its move to shift the key concepts from object nouns (knowledge, synthesis, etc.) that emphasize product/outcome/skill to active verbs

(creating, analyzing) that highlight the cognitive process, the change to Bloom's Taxonomy holds out a promise (in theory, at least) to facilitate more focus on a student agency/learning lens than one of teacher authority/curricular standards. Even so, in application, the classification of synthesis as a "skill" or "outcome" continues to exert itself in teaching materials and guides (i.e., textbooks), as well as in scholarly examinations of student research practices. As a result, this approach to conceptualizing synthesis translates into classroom pedagogy. Because students inevitably translate our pedagogy into their own methods of knowledge construction, it should come as no surprise when we find students' synthesis efforts fall short in their efforts to demonstrate higher-order conceptualization processes.

Yet, the very *act* of synthesis begins long before the writing begins, and some writing scholars whose work draws from educational and cognitive psychology seek to shift the conversation in that direction (e.g., Flower; Flower and Hayes; Segev-Miller; Fleckenstein; Mateos and Solé; Schumacher and Nash). David Hyerle's work *Visual Tools for Transforming Information Into Knowledge* addresses this, writing that knowledge transformation efforts like synthesis (and synthesis instruction) are still framed as a "linear textual representation" outcome (12). He argues, in contrast, that "*cognitively* we process beyond the linear mindset, but we ask students to *show* their thinking in primarily linear terms" (12; emphasis added). In other words, there is a gap in our pedagogy between students' learning processes and the products we ask of them. This apparent disconnect between the concept of synthesis and how we *teach* the concept is one which this study seeks to address. If the process by which students perform synthesis is more complex than a linear textual outcome can capture, our pedagogy—to be effective—must adapt. As both Spivey and Segev-Miller describe synthesis, it is *first* a mental or cognitive performance in the service of comprehension. From an educational psychologist's lens, Segev-

Miller describes “discourse synthesis” as a series of transformative strategies that *begin* at the cognitive level. This is an “active and constructive process” in which “writing is mainly an activity of knowledge transformation” (Boscolo et al. 421). If such concepts as transformation and construction take place at a cognitive level, and if we are asking student writers to engage in synthesis beyond simplistic variations of summary (knowledge telling), our writing pedagogy should focus first on the cognitive processes of *developing* knowledge transforming behaviors (Boscolo et al. 421). In other words, before we ask students to develop and perform synthesis as a written structure, we need to take a step backwards to first teach them to recognize the cognitive processes they use to construct those transformations.

It is worth noting here that synthesis as a *concept* or *cognitive process* receives little to no attention in some of our field’s most significant publications focused on current research trends. In their 2012 edition of *Exploring Composition Studies: Sites, Issues, and Perspectives*, Ritter and Matsuda’s index and table of contents make no mention of synthesis writing as an object of study. Similarly, the index of Linda Adler-Kassner’s and Elizabeth Wardle’s 2015 edited collection *Naming What We Know: Threshold Concepts of Writing Studies* contains nothing listed for synthesis, discourse synthesis, or writing from/with sources. Heilker and Vandenberg’s *Keywords in Composition Studies* demonstrates a similar absence. Therefore, despite being a site where student agency and metacognition are prominently at work, the subject of synthesis writing practices (and how we teach it in the first year writing classrooms) and the materials we rely on to develop teaching materials and theory seem to marginalize synthesis into the realm of an outcomes/skill set. This is troubling, especially given that process theory continues to be a driving force in our field’s pedagogy; if our theoretical approach *frames* learning as a *process*, our in-class praxis should also be consistently framing the work we ask of students that way. It is

also troubling given the resurgence of interest within our field in metacognition, student agency, and cognitive processes—all vital to process theory and, more recently, Teaching for Transfer. These are issues that will be discussed in further detail in the Literature Review.

This background leads me to ask what might be revealed by asking different questions? Large scale studies like the Citation Project have some roots in the question, “Why do students plagiarize?” What are we *really* asking students to *think about* and *do* when we ask them to discover and synthesize source materials as part of a research assignment in the freshman writing classroom? Rather than asking “How do we teach student writers to use sources correctly?”, shouldn’t we be asking, “How does student thinking change when writing with sources? And how does that influence the way we teach?” Such transformational thinking is at the heart of our expectations when we ask students to “create” new knowledge as part of research writing. How exactly does one teach “knowledge transformation” to novice academic writers? How is synthesis writing framed by our pedagogy and our theorizing of the research assignment? Even further, how is our pedagogy framed by our field’s rhetorical roots in the area of Invention?

Looking beyond the search behaviors of freshmen, the task of synthesis is universally admitted to be a difficult cognitive exercise for novice writers (and even experienced ones). As previously mentioned, synthesis as a writing practice has been described as under-researched (Mateos and Solé; Segev-Miller; Kaiser Lee) but what scholarship *is* available to 21st century teachers concludes that “performing synthesis tasks proved too demanding . . . for most college students” (Mateos and Solé). It is also equally difficult to teach. My research questions are grounded in the question of why our current paradigms of synthesis instruction are falling short, and whether a different approach can resolve that difficulty. Synthesis is a cornerstone of academic writing—from analysis to research writing. Yet, throughout decades of “turns” within

our field, we still seem to be searching for a uniform and successful synthesis pedagogy.

Teaching materials and online teaching forums abound with tips for helping students produce academically appropriate synthesis writing, suggesting practitioners may still be looking at synthesis as a skill-based practice. To date, it seems that the only large-scale studies on synthesis-as-source-use emerge from studies on information literacy, such as the Citation Project and Project Information Literacy, which report evidence that students continue to struggle with this highly complex cognitive practice but these projects emphasize citation over cognition.

While authors of these studies call for more research into a metacognitive approach to teaching synthesis behavior, it is still part of an information literacy focus rather than a rhetorical one (Jamieson “What the Citation” 116). This necessarily limits the scope of possible solutions.

Jamieson’s work on the Citation Project leads her to a conclusion that points to an important site of my own research questions of *why*:

The data indicate that, nationally, students are broadly able to identify, locate, and access information from apparently appropriate sources in sanctioned ways; however, a closer look at which texts are cited and *the ways they are incorporated* into the papers reveals the need to go beyond what has for many become a *checklist mentality*. (117; emphasis added)

Could it be that this “checklist mentality” is actually a byproduct of how our field’s pedagogy and teaching methods are framing synthesis? I believe so. Post-Process theorists certainly argue that Process theory has become, at least insofar as it has been translated into instructional materials, a lock-step procedure of moves, a “series of codified phases that can be taught” (Breuch 119). Composition textbooks⁴ often represent the writing process as a linear hierarchy of moves, like bullet lists and flow or cyclical charts, when we know it is more of a recursive and highly messy process. Even one of the most frequently used resources for writing

⁴ Sample titles include: *McGraw Hill Guide: Writing for College, Writing for Life; Norton Field Guide To Writing; They Say/I Say; everything’s an argument.*

teachers and students, Purdue OWL, includes a page titled “Stages of the Writing Process,” presented in step-by-step format. Synthesis is part of that writing process, and instructional passages found in many first-year composition textbooks treat it in terms of reading-to-write steps. For example, in Lunsford and Ruskiewicz’s *everything’s an argument*, the chapter “Using Sources” defines synthesis as “figuring out how what you’ve examined supports your specific claims” (419). The authors then provide a series of procedural writing steps, from “paraphrasing or summarizing sources” to “work to introduce or frame such borrowed materials so readers grasp their significance” (420). While the authors go on to caution students against simply providing “a string of sources . . . without ever getting all these authorities to talk to each other or with the author,” and provide appropriate writing strategies to connect their sources, the directions that follow do not guide students through one of the more difficult processes of synthesis: the cognitive processes involved in conceptualizing ideas at an abstract level. It is not so difficult to see that if synthesis is being *taught* as a check-list procedure, novice student writers are going to reproduce this in their approach to knowledge construction, thereby limiting their cognitive input.

In their *Guide to Composition Pedagogies*, Howard and Jamieson observe that teachers who assign research papers agree on “what they want the paper to accomplish” (232), but the language of their assignments do not consistently reflect a focus on *inquiry* (Head and Eisenberg). As I shall argue in this research, an inquiry-driven pedagogy might be better facilitated if framed along lines of rhetorical invention.

The Questions

These observations led me to a series of questions emerging from my encounters with interdisciplinary scholarship in educational psychology, visualization theories, and cognitive and neuro-sciences, which frequently intersect in an emerging disciplinary field known as Mind, Brain, & Education—MBE. These questions also emerged from my own experiences teaching the research assignment as part of a second-semester first year writing sequence (FYW2) at Auburn University at Montgomery (AUM). My research premise is based on questions of both an epistemic and interventional nature. First, in what ways does the interventional, hermeneutical heuristic of digital concept maps (DCMAPs) impact students' epistemic abilities? Specifically, if we can teach students to view synthesis as a cognitive process of structuring knowledge (Schema Theory⁵), what benefits might be realized? Second, what role might DCMAPs as visual representation of student connections and knowledge conceptualization play in promoting active and progressive transformation of ideas? Finally, can MBE scholarship and theories, when combined with an understanding of Information Visualization as a cognitive process, productively inform assignment design for synthesis and research writing in the FYW2 classroom?

Purpose of This Study

This is a small study, using a mixed-methods, Design-Based Research methodology, which allows for the exploratory and descriptive nature of my research. In pursuing the lines of inquiry driven by my research questions, my approach requires an intentional move away from rhetorical invention in its “non-epistemic” form, which Lauer defines as simple rhetorical

⁵ Schema Theory will be explored in more depth in the Literature Review, but is essentially defined by cognitive scientists as the way our brains organize acquired knowledge in the form of units, creating meaning by relating patterns of associations (Jonassen, et al. 16).

support of a thesis (*Invention* 125). Instead, this study frames the discussion of synthesis as an extended process of inquiry “designed to help writers to create new knowledge . . . and reach new insights” (synthesis) rather than “to find and deploy existing information and lines of argument . . . already known” (Lauer *Invention* 123).

My study is grounded on the premise that resituating the subject of synthesis as rhetorical invention provides a promising turn. Janice Lauer, Janet Atwill, Richard Young, and Peter Simonson provide key stepping stones to my argument that our field and our pedagogy would benefit from a fresh infusion of rhetorical invention theory to our work with teaching synthesis to “novice” writers. Such a renewed and focused discussion of invention matters very much to our field’s current scholarship and pedagogical practices. Over the last decade, our field’s theoretical and pedagogical interests have increasingly focused on student agency and metacognition. Even so, our field’s literature offers little theoretical assistance to specific interventional approaches to teaching synthesis in the first-year writing classroom other than heuristics. Reading-To-Writing heuristics employ the terms of creation but never really *model* the cognitive origins of that creation beyond a call to create new knowledge. How exactly students interpret that continues to produce summary but without transformation (Segev-Miller; Jamieson). In this knowledge gap, my dissertation study has taken shape: using cognitive mapping—specifically, digital concept maps—to actively design a visualization of the students’ cognitive representation of new knowledge and meaning (synthesis).

This dissertation will draw upon a number of rhetoric and composition scholars whose work infuses much of the modern scholarship on writing pedagogy in the area of rhetorical invention. As a foundational concept informing our curricular designing practices for the freshman writing classroom, invention’s long history in our field manifests today in a myriad of

ways, from journaling to listing, and the ever popular heuristic of graphically mapping out early ideas for a writing project. As a pedagogical tool, such invention practices have been a highly effective staple in my own freshman writing classroom. But not all “mapping” is created equal, nor is invention always confined to the beginning of the process arc. In fact, in the coming chapters, I will argue that synthesis—what we often teach well past the early stage of the arc—is also invention. Likewise, in a composition classroom a cognitive process map—a map that traces the cognitive processes and associational thinking involved in knowledge acquisition and construction—must necessarily capture more than just a starting point because these processes are ongoing and recursive in the types of meaning-making occurring in synthesis writing. Synthesis is hard, but such a map may provide a useful tool for representing a novice writer’s internal thinking involved in structuring knowledge, as well as the “conceptual restructuring” that occurs in synthesis (Segev-Miller 2).

These discussions of structure have led to my interest in framing synthesis not as a product of writing but as a meaningful performative cognitive process. As educational psychologist David Ausubel describes it, meaningful learning happens when “new concepts and propositions” are integrated “into existing concept and propositional frameworks held by the learner”; a “cognitive structure” is created as learning happens (Novak and Cañas 3). Based on these premises, I am studying freshman writers’ synthesis behaviors as a cognitive process by investigating an intervention I have been using in my own composition pedagogy: the DCMAP as a tool of invention and cognitive process mapping.

Key Terms & Assumptions

There are a number of terms and related assumptions that are important to this study. The following terms are more deeply explored in the Literature Review, but their importance deserves a brief overview in this chapter as they establish significant terminology and conceptual material before moving forward.

Agency: Agency is a highly complex and deeply theorized term, in our field as well as others. There are a number of scholars who have defined it in varying ways according to their theoretical and disciplinary priorities. My use of this term is influenced by the works of Marilyn Cooper as well as Purdy and Walker, along with cognitive scholars (Flower; Bruillard and Baron; Novak and Cañas; Jonassen and Reeves). In this project, I am using the term *agency* to refer to students' conscious and intentional motivation, as well as their self-perception as knowledge designers, that influence their generative choices in writing (i.e., knowledge *designers*). The term implies their active engagement with and value of personal prior knowledge (both epistemic and practical). In other words, agents (i.e., the students) are meaning makers and knowledge designers. Cognitive mapping is designed to be a tool that promotes the development of such agency.

Creation & Knowledge: The decision to deploy a digital concept map as my intervention emerges from constructivist approaches to composition theory, in which the act of constructing a representation of students' cognitive processes in the research process employs the language and moves of map making. The map, however, begins as a blank slate, and is presented in the classroom as a place where students map emerging perceptions and connections, not existing pathways of a pre-existing construction . . . an overt act of creating knowledge. This, as Karen LeFevre defines it, is invention, a socially constructed act that ““is conceived...as the

process of actively creating as well as finding what comes to be known and said in the discourse of any discipline” (qtd. in Lauer *Invention* 100). As if to signify its value, *create* now occupies the most complex level on the cognitive framework of educational objectives, and is at the heart of many of our field’s means of designing and assessing knowledge- and meaning-making outcomes and goals for the college writing classroom. Given the constructivist approach I am taking in this study, such rhetorical shift would seem fortuitous; however, as I explore later, that shift also complicates our theorizing of our approach to synthesis pedagogy.

An additional reason for choosing a digital visualization approach to an interventional space rather than text production emerges from cognitive science research. While the term “creation” is increasingly applied to multimodal compositions, its dominant application remains textual, which I argue (with scholars like Joddy Murray) may limit our pedagogy. In focusing on discursive forms of text as product, our field may be missing the benefits of understanding fully the role of visualization in the cognitive process of interpreting and constructing the types of knowledge valued by composition theorists. From the field of Educational Science, Eric Bruillard and Georges-Louis Baron point out that the very nature of a concept map (CMAP) lends itself to such constructive acts. If we accept the premise that student synthesis writing is a cognitive *process*, the potential afforded by CMAPs in this constructive process is worth exploring in both pedagogical/instructional and student learning/cognitive terms. My design-based intervention to teaching synthesis leans heavily on such cognitive theories of tools to facilitate an intervention that graphically facilitates this designerly role, as I will discuss in more depth in the Literature Review. Finally, my guiding critical framework draws from Nancy Spivey’s summary of the epistemic nature of writing (a commonplace for many writing scholars and instructors). It is a constructivist theorists’ truth that meaning is *constructed* by both writers

and readers; however, that construction is not limited to the visible product. Its origins are rooted in active construction and transformation at non-visible levels, which Spivey describes as “a mental representation of meaning” (256). This invisible, ongoing cognitive act of construction begins at a more abstract level, before writing even begins, a concept explored by many education and cognitive scholars (e.g., Nesbit and Adesope 419; Haas and Flower 167). As a digital representation of ideas and connections, CMAPs may be one way to create a concrete visualization of the yet unseen “mental representation” (a cognitive construct) of student knowledge in both pre-existing and emergent forms.

Representation as Active & Meaningful Learning: At the core of my examination of CMAPs is the definition and role of representation in the cognitive processes of writing and pedagogy. I am defining representation through a cognitive lens: it is not an act of mirroring but a performative cognitive translation. Long and Flower maintain that the act of writing is influenced by student writers’ choices in how they “represent the task to themselves,” not just by the genre characteristics of the assignment (108). Here, the field of MBE may play what some have described as a “mediating” role in facilitating this encounter (Samuels; Fischer; Sousa; Tokuhama-Espinosa) by framing discussions of Active and Meaningful Learning pedagogies in ways that allow for cognitive and affective considerations. MBE scholarship may also provide new pathways for discussing revisions to the ways and materials we use to teach synthesis writing in the classroom. The act of representation makes it a potentially useful site to introduce DCMAPs as part of the research writing process. These maps provide a key opportunity to explore intersections of visual, cognitive, and writing process theories for productive potential. Such a lens facilitates ways of framing the use of DCMAPs as an interventional tool in terms of student agency as well as cognitive-based pedagogies. Because affordances of the DCMAP

create a synchronous space for students to actively generate structural knowledge (Jonassen et al.), the potential contributions by MBE's emphasis on cognitive concepts of *learning* provide a great deal of "explanatory value" (Battro et al. 8) for my research into synthesis as an inventional, cognitive process.

Inventional Intent: As part of theorizing synthesis-as-process in my research, I think it is important to take a step backward to look at inventional intent as a way to explore agency in this process of knowledge building. In doing so, I draw again upon Janice Lauer's definitional framework for rhetorical invention, in which she points to Flower and Hayes' work with a socio-cognitive, constructivist framework and grounded theory to explore the role of "inventional intent" to theorize invention and inquiry as a cognitive process (Lauer 101-102). As other scholars have noted, however, this reveals a gap that exposes a key question at the heart of my own research: how do we discern or measure intent and, even more challenging, how do we help students recognize and operationalize their agency in the "creation of something new"? My research study frames student knowledge creation as a process of creation *performed* by students; therefore, their visualization mapping activity becomes the space where I hope to look for significant markers of student intent and invention as cognitive processes.

Applied this way, DCMAPs might provide a pathway to a fresh approach to ways we theorize synthesis, and the importance of taking a new look at synthesis practices and pedagogy now that current interdisciplinary contributions made by MBE, Design Theory, and developments in Cognitive Science provide new lenses.

The Intervention: Concept Maps (CMAPS) & Cognitive Mapping

All CMAPs are not created equal; like many writing technologies, they have evolved along with our developing theories of knowledge, writing, and cognition. Therefore, it is

important I use CMAP scholarship to clarify two key terms: concept mapping and mind mapping. These two terms are often mistakenly used synonymously in some discussions of learning and heuristics (Davies; Eppler; Schrock). While these differences will be explored further in the next chapter, it boils down to relationships and associations (Davies 284), a difference that might be productively explored in terms of information vs. knowledge when discussing synthesis (Tergan et al.), as I attempt to do in this study.

However, in composition studies' scholarship, the subject of CMAPs as a passive heuristic device vs. active learning process is a bit murky. This gap represents a notable opportunity for inquiry where I might examine synthesis practices in first year research writing. I believe DCMAPs may be worth exploring as more than just a prewriting heuristic; its affordances as a digital space⁶ of knowledge visualization, reflection, and representation might hold potential for pedagogical and theoretical means of advancing critical thinking in students' synthesis writing practices. Specifically, the space and creative behaviors afforded by concept mapping may provide a visible, evolving account of student knowledge building to promote discussion of synthesis as a process (not merely artifact or outcome) and as a rhetorical invention behavior. This is where my study begins.

⁶ The emphasis on digital here reflects the value of having an unlimited, archivable space for developing maps, and integrated tools that display a historical trace of ongoing changes.

CHAPTER II

LITERATURE REVIEW

Reasoning Behind the Literature: Two Branches

Despite its acknowledged importance in academic writing goals, synthesis—as it is represented in composition scholarship on student research methods and teaching materials—appears to be relatively underexplored within our own field, and not yet well theorized in terms of its form as either a cognitive or a writing act. As compositionists, our research is heavily focused on classroom pedagogy, where cognitive threads have emerged in discussions of writing transfer in terms of metacognitive and reflective writing (e.g., Yancey et al; Nowacek; Moore). In the specific area of synthesis writing, however, there appears to be little research that tackles this from a cognitive, let alone intentional, approach. While the available scholarly research from composition studies has been somewhat limited on this subject, there has been a recent rise in scholarly work (both empirical and analytical review) in both educational/learning and cognitive sciences that attempt to address issues related to synthesis writing and processes more directly. Two areas where this is happening is in the field of neuroeducation and cognitive mapping, which provide me with necessary resources to begin addressing this perceived gap in research. My study relies on conceptualizing synthesis as both a creative and constructive act of knowledge transforming; such a path is especially productive when approached through a framework of our field’s scholarship of rhetorical invention (Lauer, “Rhetorical Invention,” 10). Segev-Miller’s study of discourse synthesis provides a model for this approach to teaching synthesis explicitly as a “hybrid task . . . of comprehension and production,” asking students to engage in both interpretation (hermeneutical) and creation processes through an interventional heuristic (“Writing” 5-6). This cognitive focus, together with Lauer’s definition of invention as

both a “creative and interpretive” act (“Rhetorical Invention” 10), create the nexus where my study’s design takes shape.

I believe this approach will be useful for our field because of its potential implications for how we teach synthesis and how we understand the invention process of student writers. To that end, it is important to note here that this is not an exhaustive review; it is meant to represent and highlight the types of scholarship available to teachers of composition for pedagogical support in teaching discourse synthesis in a first-year writing course. Thus, to better theorize my study, I have divided this Literature Review into two branches (Branch #1 is cognitive science and cognitive mapping, and Branch #2 is rhetorical invention) to better frame their relevant theories and contributions to my study’s methodology and design. I begin with a brief overview of important concepts drawn from educational neuroscience and cognitive mapping scholarship before moving on to our field’s treatment of synthesis.

Branch 1: An Overview of MBE & Cognitive Mapping

My study’s design draws from a matrix of interdisciplinary connections, bound together by my focus on rhetorical invention and synthesis as a cognitive process; therefore, my focus is limited to scholarship from fields that share an overlap in cognitive areas and practical, applied theory and pedagogical interests. Beginning with Flower and Hayes’ works on cognitive theories of writing in the 1980s, this literature review explores relevant cognitive process theories that have evolved thanks to influences from multiple disciplinary views of learning. Of particular value to my own research are the influential theories of learning that are represented in the scholarly collaboration taking place in the field of neuroeducation, also called Mind, Brain, and Education (MBE). Specifically, the emphasis on conceptualization and concept building

processes in MBE research contributes to my focus on finding ways to improve the “conceptual thinking skills” of our students through synthesis pedagogy (Willis 62).

In this chapter, my purpose is to locate my research within the field of composition studies but also the productive pathways inspired by these cognitive and educational scholars in the field of MBE because it will have implications for how we understand and teach synthesis as a process of invention in our writing classrooms. My examination of synthesis as cognitive invention within rhetorical and compositional theory is informed by relevant contributions from cognitive science, educational design, and concept mapping to facilitate the discussion of digital concept mapping (DCMAP) as an intervention. In order to more effectively explore the connections to our field, several concepts connected to MBE and cognitive mapping need to be identified and discussed, as framed by the exigence of the writing classroom.

To teach such a difficult cognitive process as synthesis, I argue we can benefit from neuroeducational research that connects an understanding of neuroeducational science to active learning practices such as those found in the process-oriented writing classroom. MBE as a field defines itself as interdisciplinary in nature, exploring scholarship in educational psychology, visualization theories, and cognitive and neurosciences. David Sousa, one of the founding scholars of the field, points to the 1990s as its origin, emerging in an era of often controversial approaches to interpreting brain research in terms of educational applications. In his preface to the book *Mind, Brain, & Education: Neuroscience Implications for the Classroom*, Sousa visually captures the nature of this field, defined as “the intersection of psychology, neuroscience, and pedagogy,” as seen in Figure 1 below:

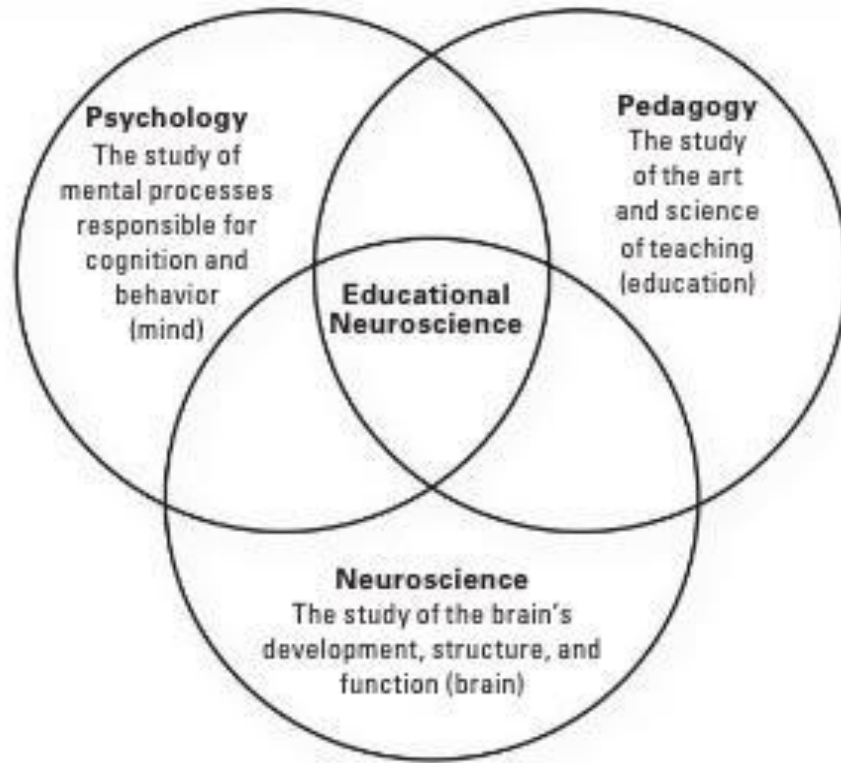


Figure 1: David Sousa's Graphical Representation of MBE's Interdisciplinary Origins (2)

MBE scholars explain that the complexity of these “parent disciplines” makes it challenging to provide a simple explanation of the field’s theoretical core, especially in terms of epistemology (Tokuhama-Espinosa 5; Sousa 22). However, a unifying focus of the field is that its research benefits educational and pedagogical practices. MBE scholars like Sousa, Tokuhama-Espinosa, and Battro et al. point to the nature of the field’s research as grounded in empirical studies on how our brains learn to create, in part, what Battro, Fischer, and Lena refer to as “new networks of knowledge” (5). Scholars working in this field are quick to point out the precarious nature of its inquiry, especially when the flow of accepted knowledge is often perceived as a one-way street from researchers trickling down into the classroom (Vidal; Fahenstock; Bruer; Tokuhama-Espinosa; Sousa). However, Sousa, Fischer, and other dominant scholars in MBE argue that the modern era of educational research must instead be a mutual,

collaborative exchange. There is also still much disinformation, as many MBE scholars point out, that results in what they refer to as “neuromyths”: classroom practices drawn from popular publications like left-brain vs. right-brain learning⁷ or the Mozart Effect (music’s effect on learning). These approaches have been criticized as drawing from either lore-influenced beliefs about how the brain functions or misapplied neuro-research (other myths are explored by the National Research Council in *How People Learn*, as well as documented by others like Tokuhamma-Espinosa, Goswami, Willis, and Hruby). As Battro et al. observe, our inquiry into learning itself requires work “beyond the laboratory and its strict, traditional models of learning. The new learning space for the neuroscientist is the classroom” where—significantly—the cycle of information exchange necessarily calls upon the subject matter expertise of the teachers to become researchers on the local, classroom level (“Introduction” 10). Thus, I have limited my attention to scholarship with an emphasis on the partnership of educational and cognitive sciences.

Definitions: Concepts From MBE

There are several key concepts from MBE scholarship that need to be briefly introduced, as they directly contribute to the following discussions of cognitive mapping, especially in my use of digital concept maps as a constructivist learning space for writing students.

Patterns, Patterning: Our brains rely on patterns to create meaning. Educational neuroscientist Judy Willis writes “[p]atterning refers to the meaningful organization and categorization of information” (59). Thus, “meaning making” occurs “[w]hen students’ knowledge increases through pattern recognition and by matching new information to memories,

⁷ Goswami explains that this myth is based on “hemispheric specialization,” resulting in pedagogy that categorizes students and praxis based on hemispheric dominance and learning preferences, an approach that has been disabused by neuroeducation scholars.

[making] the neural networks . . . more extensive” (Willis 59). In other words, meaning making occurs moving from preexisting knowledge to creating new networks of knowledge.

Pattern Building and Learning: The term “learning” is typically interpreted as a measurable process. Neuroscience couches its discussion of learning in terms of “neuroplasticity,” which in simple terms is the construction of new neural pathways or “networks . . . by repeated activation of the circuit, such that practice makes permanent” (Willis 58). Educational science authors Ambrose et al. write that the way students organize their knowledge has a direct impact on learning. For example, defining “organize” as a *process of making* and arranging connections and associations leads to framing that behavior as a complex knowledge structure based on complex pattern building (Ambrose et al. 45-47). Students whose prior knowledge and experiences are still relatively underdeveloped in terms of depth (assuming time plus experience adds depth) have yet to accumulate the types of “meaningful ways of organizing the information they encounter in our courses” (Ambrose et al. 43-44). These patterns and pattern building efforts are essential to how we organize knowledge (Ambrose et al. 46-47).

Creativity & Conceptual Thinking: Educator Mariale Hardiman, co-developer of the Johns Hopkins University School of Education’s Neuro-Education Initiative, defines creativity as “the ability to produce work that is both *original* and useful in some way . . . bringing something *novel* into being and *transforming* the existent” (“The Creative Artistic Brain” 229; emphasis added). Such a definition is remarkably similar to the definition of invention as *techne* (art) as “productive knowledge” in the sense of creation (Lauer “Rhetorical” 11). The definition also echoes language commonly seen in explanations of synthesis in writing textbooks: original, novel, transformed. From a neurological point of view, creativity demonstrates “divergent

thinking . . . a complex thought process” (231).⁸ Hardiman points to research that suggests “visual and performing arts provide opportunities for students to demonstrate new patterns of thinking and learning” including developing skills like “envisioning mental images to perceive in novel ways” (233-234). Cognitive mapping such as concept mapping is the sort of visualization that incorporates these qualities. Sousa also points to the transferable potential of habits of mind developed by employing visual arts as a teaching and learning technique (*How The Brain Learns* 146–150). Such creative production (*techne*) is facilitated by concept mapping’s construction affordances and theoretical underpinnings. Admittedly, while cognitive mapping may not be a typical category of visual art as Sousa references here, the *affordances* of concept mapping ask students to utilize color, shapes, and other multimodal elements to represent and construct their thinking in a non-linear (or divergent) way. The kinesthetic nature of concept mapping may also facilitate the sort of active creation/representation that moves the user toward novel perceptions.

Representation/Visualization: David Sousa defines the process of employing “visual cues” as part of the learning process as “imagery,” which is “the mental visualization of objects, events, and arrays related to the new learning and represents a major way of storing information in the brain” (*How* 235). As representation is often described in terms of constructing an internal image of a concept, it is not a far reach to connect this to the research Sousa points to that demonstrates our “visual processing system is available even when the brain is creating internal pictures in the mind’s eye” (235). Sousa also points to research by Helene and Xavier, who conclude that “[m]ental imagery can be so powerful that learning a skill through imaging it can

⁸ This is a trait also valued by our own field’s attention to habits of mind as a framework for learning (NCTE; Miller and Jurecic 13; Flower and Hayes “The Cognition”).

be almost as effective as actually performing it” much like the function of mirror neurons⁹ in the brain enable us to mimic what we see others do (235). An understanding of how these mirror neurons function, write Rizzolatti, Fogassi, and Gallese, may help us understand the importance of visualization in developing an understanding of a concept, or understanding why we make connections (61). Moreover, such mirroring seems to be in play in the very classroom activities and tools we integrate into our praxis. Sommers and Salz observe that while “[f]reshmen might not be able to fashion their own tools or even know which tool to use under what condition, . . . they learn by holding the expert’s tools in their hands, trying them out, *imitating* as they learn” (135; emphasis added). Rizzolatti et al.’s description of how mirroring works suggests mind mapping (similar to concept mapping) may be seen as “a specialized form of imagery . . . to help show relationships between and among concepts, and how they connect to a key idea” (Sousa *How* 235).

Cognitive Mapping, DCMAPS, & Cognitive/Concept Transformation

Critical thinking is hard for novice and mature students alike, and in the form of conceptual transformation¹⁰ is even harder. This is precisely the reason why graphic organizer interventions are a mainstay in composition pedagogy for modeling and organizing ideas, idea discovery, sentence mapping, clustering, or reading comprehension. Concept mapping is often included in this category of tools; however, it is a term frequently misused and underutilized. In fact, concept mapping more often appears in scholarship from fields such as education, sociology, and nursing, but lacks much representation in composition scholarship—and even

⁹ Definition: “mirror neurons respond to actions that we observe in others. The interesting part is that mirror neurons fire in the same way when we actually recreate that action ourselves. Apart from imitation, they are responsible for myriad of other sophisticated human behavior and thought processes” (119).

¹⁰ This phenomenon is one that is discussed by scholars in both MBE and rhetoric/composition as it relates to learning processes and synthesis of knowledge. The National Research Council text *How People Learn* explores this in terms of moving from novice to expert as a process of learning via constructing “new” knowledge patterns (70).

then is more often covered as a deficit-based instructional tool (Kosminsky et al.; Nesbit and Adesope; Rosenberg et al.). Concept mapping as an intervention is first credited to Novak and Cañas, whose theorizing and applications as an aide to cognitive processing of information became the foundation for further research in areas of information visualization, knowledge visualization, reading analysis, and cognitive aspects of educational instruction and assessment. Novak and Cañas based their research on Ausubel’s theory of meaningful learning, which states that a learner’s pre-existing knowledge is essential to learning “as it forms the foundation for new knowledge. Meaningful learning occurs when the learner is able to make connections between what is already understood and what is still to be comprehended” (Ifenthaler and Hanewald 4).

As an instructional tool, concept mapping is often confused with other “mapping” tools like mind mapping, idea webs, or argument mapping, when in fact they are decidedly different (Davies). All are considered types of cognitive mapping, but there is an important difference: while mind maps and idea webs emphasize free-form thinking that tends to be surface-level connections, concept mapping emphasizes visualizing both *associational* and *relational* thinking.¹¹ Eppler compares CMAPs and mind maps as two different “tools for knowledge construction and sharing,” suggesting that while they have a number of characteristics in common, they differ enough to discourage treating them as interchangeable. Davies observes that because the mind map (commonly referred to as a graphic organizer of early inventional stages) is more freeform and less structurally limited, it better suited to more creative brainstorming efforts (281). However, CMAPs create a more structured ecosystem of ideas and active

¹¹ The terms “associational” and “relational” thinking come from readings in both MBE and concept mapping research. Davies defines the difference between the two in terms of the types of types of meaning being made: relational refers to complex relationship building using multiple levels of function, while associational refers to more superficial connections like listing or similar/different.

relationship building, productive as a tool to operationalize schema theory's concepts of knowledge structures (Jonassen et al.). Finally, while mind maps are typically applied at the beginning of a process to informally brainstorm ideas or for note taking, CMAPs more commonly develop and represent relationships to "clarify . . . an abstract concept" (Eppler 203). While concept maps are often described as more hierarchical in structure than mind maps, recent studies have demonstrated that the rhetorical function and design of the structure can be exploratory and, therefore, more flexible for scaffolding structures of knowledge (Davies; Eppler; Wheeldon and Faubert; Bruillard and Baron). In sum, such function suggests that concept maps are more than just a visual organizing tool like other instructional graphic organizers. Concept maps, as explained by Hyerle, are a type of visual tool that embodies "underlying theory" to serve as both process as well as "the form of contents and processes combined," a form that "often follows its function" (38-39). If theorized in terms of an inventional cognitive process, instructors employing concept maps may use the opportunity to explicitly model ways the map's affordances serve a performative representation of students' constructive (and cognitive) process as well as representing the act of *transforming* content (and ideas) through design choices. This is where a metaphor of mapping proves useful when used to explicitly frame in-class mapping and freewriting activities. For example, key structural and functional features of a concept map include concept nodes and connector lines (Novak and Cañas call them "cross-links") between nodes; this combination of these features function as theorized structural processes of knowledge building.¹²

¹² For students, this takes the form of the vocabulary lists provided in the Appendix, in which the vocabulary of concept mapping strategies intentionally parallels that found in a synthesis vocabulary sheet that contained terms commonly associated with synthesis practices, such as those found in textbooks, Bloom's Taxonomy, and outcomes.

A distinctive feature of CMAPs is the connective terminology (connector labels) that demonstrates the relationship between concepts represented in nodes, a function shared with synthesis. Novak and Cañas point out that such connections play a vital role in knowledge creation, and in particular “new” knowledge, because these “cross-links often represent creative leaps on the part of the knowledge producer” (“A Summary” 5). Concept maps then function as a visual representation of the learner’s “knowledge structures . . . store[d] in their minds” (Jonassen et al. 1), or “mental schema” that inform the way we process and understand experience (Bruillard and Baron 331). Synthesis strategies work very much the same way. Definitions of synthesis available in scholarship and teaching materials frequently highlight the importance of such re-structuring of knowledge as a distinguishing characteristic of successful student writing, commonly using variations of such terms as *combining*, *organizing*, and *new*. Concept mapping, then, explicitly represents this strategy in a visual mode.

Concept maps also serve as tools for cognitive offloading, essential when working with multifaceted “concept structures” too complex for our “working memories” (Tergen et al. 168). Nesbitt and Adesope agree, pointing out “[p]lacement of nodes may reduce cognitive load by reducing the visual or memory search required to distinguish or associate similar concepts. Winn (1991) reviewed research suggesting that pre-attentive visual processing of diagrams, such as visual chunking of collocated objects, lends efficiencies that cannot be obtained from text” (418). Synthesis tasks certainly qualify as such complex, multifaceted structures, and prove exceptionally challenging when the writer is less experienced. Figure 2 following illustrates the functional components of a concept map, as illustrated by one of its foundational scholars, Cañas:

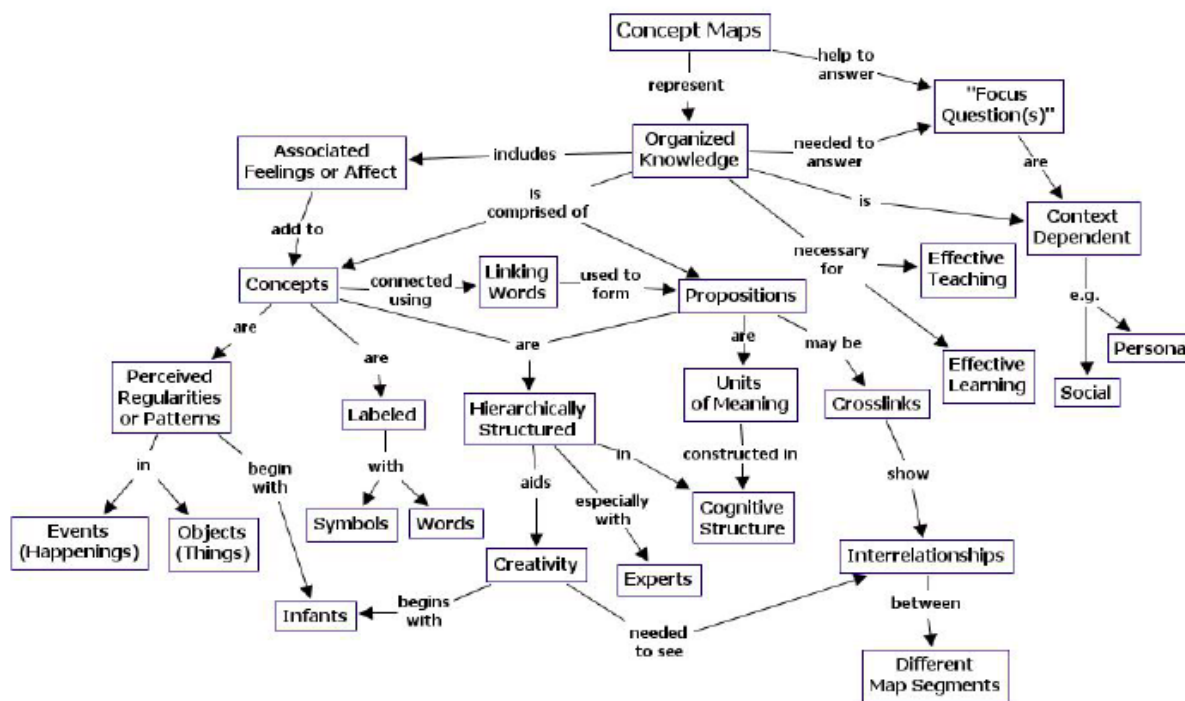


Figure 2: From Novak and Cañas, “A Concept Map That Describes Concept Maps,” *The Theory Underlying Concept Maps and How to Construct Them* (6)

Of course, the most important aspect of concept mapping for my study is its visual construction affordances, and its usefulness as an invention-based “cognitive tool” for both instruction and learning (Bruillard and Baron). Tergan et al. point to the benefits of such mapping for students like my first year researchers engaged in complex cognitive practices when these “structures inherent in the knowledge and information are made explicit” through visual construction (167). As important is the knowledge communication potential of such mapping; not only can such maps communicate to an audience what the student writer perceives as content and connections, but (and most importantly to my study) can also assist students in visually representing *and constructing* their own *process* of knowledge- and meaning-making. Jonassen et al. describe concept maps’ function in this way as representations of the cognitive “knowledge structures” that humans use to understand experience (331-332). In this role, students’ concept

maps may then become an observable space for potential study as a location where meaningful learning might take place.¹³ What makes these maps particularly useful is that using them taps into what cognitive dual coding theory postulates as our cognitive processes' reliance on the associative functions of employing both linguistic and visual/symbolic representations (the two codes) to process and operationalize knowledge (Clark and Paivio; Paivio; *Stanford Encyclopedia of Philosophy*; Morton). In other words, we learn best when we structure knowledge by associating a combination of text and imagery to process experiences to make meaning. In my study, when concept mapping is so theorized and employed as an instructional and learning tool, the results may address the complex burden of cognitive synthesis processes in a number of ways. One such area of benefit is illustrated by research by Nesbit and Adesope, who conducted a meta-analysis of research on concept maps and point to the role of "prior knowledge" retrieval and cognitive offloading. The cognitive associational power of concept mapping seems to suggest its usefulness as a learning and teaching heuristic for the purpose of tackling complex meaning-making tasks such as synthesis because of its potential for creating a bridging activity between knowledge telling and knowledge transforming (Segev-Miller). In addition, when used as an ongoing, nonlinear, structural representation of meaning making, a concept map may allow students to read nonhierarchically in more of a discovery mode, whereas the traditional synthesis writing-from-reading approach requires students to maintain an additive, linear view of source knowledge. This approach harkens back to work by Flower and Hayes in "The Cognition of Discovery," in which they point out the "myth" of discovering meaning in the process of creating new texts. In the case of first year writing students who may be practicing research synthesis as novices, this mapping process—when framed as a constructivist cognitive

¹³ Meaningful learning, according to Morton, happens when pre-existing knowledge is connected to "new knowledge" and so builds "more integrated knowledge structures."

behavior—embodies Flower and Hayes’ observation that “[t]he *act* of creating ideas, not finding them, is at the heart of significant writing” (“The Cognition” 22; emphasis added). This performative act enabled by the process of mapping may then facilitate what Nesbit and Adesope call “metacognitive engagement” by allowing students the agency to navigate the ordering of said process to make connections that are relational as well as associational (420). Simply put, a concept map provides students with a constructivist opportunity to literally map their process of creating and connecting multiple nodes of knowledge (including their own preexisting knowledge experiences), allowing them to discover an agency-based researcher identity and role as knowledge designers.

From MBE to DCMAPS

The MBE research most relevant to a study of synthesis processes is on the subject of how students’ cognitive processing of knowledge acquired from source material relies on constructivist practices. MBE scholar David Sousa notes that the human brain is designed to be a “pattern seeker, . . . wired to use past information and skills to solve new problems,” often referred to as learning or transfer (*How the Brain* 146). Part of this process requires strong *associational opportunities*, which allow our brains to make connections between new experiences/knowledge and prior experiences/knowledge. Designing classroom heuristics that create opportunities for such associational practice may create more dynamic learning opportunities, especially when framed by proven rhetorical and cognitive process pedagogies currently informing our field’s trending interests in transfer. Reflective pedagogies have long been a staple of composition, but too often presented as an afterthought, post-artifact. What if we reposition reflection to the core of the process, enacting what Flower et al. propose to foreground the “cognitive complexity” of students’ synthesis efforts to become “a feature of the writer’s

process rather than the text” (*Reading* 63)? In other words, help students frame themselves as knowledge *designers*. Moreover, moving our construction sites to the cognitive mapping of knowledge building and transformation as a visual representation (such as is possible in a DCMAP) may address the concern expressed by Flower et al. in their work *Reading-To-Writing* that our means of assessing learning—the text or genre of the research product—offer limited insights into where the learning process is taking place: in the cognitive processes of knowledge representation and transformation (63). In other words, if our goal is to teach the process and not the product as a transferable outcome, then we need to develop alternative means of teaching synthesis practices. The affordances of the DCMAP present me with a way to explore and operationalize this reasoning in my study’s methodology and design.

In sum, DCMAPs create a space where both heuristic and hermeneutic qualities are engaged, and allow me to emphasize the potential benefits of extending the approach to synthesis as *a way of thinking* (the why, or structural and procedural knowledge), as opposed to a composition of *genre-based artifacts* (the what, or declarative knowledge).¹⁴ This is useful in terms of pedagogical issues because it allows me to argue in favor of framing synthesis as invention in terms of both interpretive *and* productive acts for the purpose of *both* “constructing and conveying knowledge” in DCMAP spaces (Lauer *Invention* 123). Thus, this literature review now shifts from the potential of DCMAPs as an interventional site to foundational work on the theories and pedagogical practices associated with rhetorical invention—and its influence on teaching synthesis as an inventional hermeneutic heuristic. Specifically, the final sections of this literature review will allow me to consider how cognitive scholarship informs my approach to discourse synthesis as it is taught, as it is studied, and as it might be studied. Key literature

¹⁴ Procedural and declarative knowledge are explored in more depth in later references to Jonassen et al.’s work in structural knowledge.

selections drawn from cognitive and educational sciences are then explored as part of establishing my study's intervention design: visualizing emerging knowledge discovery and construction processes facilitated by features of DCMAPs to frame synthesis as an inventional, cognitive process that drives creative, agency-activated, student meaning making.

Structural Knowledge Synthesis Practices: Representation, Conceptualization, & Cognitive Transformation

At the risk of oversimplifying, discussions of knowledge in educational psychology are divided into three basic types: knowing that, knowing how, and knowing why (Jonassen et al. 4). It is the latter form of *structural knowledge* (i.e., knowing why) that may be operationalized using CMAPs. In other words, student-designed CMAPs seem especially promising as a graphic means by which to guide student writers to more deeply engage their research writing by activating structural knowledge. As Jonassen and Reeves argue, students may do more constructive thinking when given the role of knowledge *designers*—actively representing what they know—rather than knowledge reproducers (696). When used by student writers to graphically render concepts and “interrelationships,” DCMAPs might offer a way to represent the types of “knowledge structures” or mental schema our brains use to process information and experience (Bruillard and Baron 331).

Spivey and King assure us that when students approach synthesis as a reading-to-writing act, student writers aim to create their own text structures by organizing content drawn from other texts, in the process of which they create new categories (patterns) as a way of grouping them together in the effort to transform texts to make new knowledge (“Readers as Writers” 9-11). The problem is, at least according to all the research available that studies synthesis writing or information literacy habits of novice/freshman writers, that is not what is happening. While

measuring transfer “play[s] an important role in assessing the quality of people’s learning experiences” (*How People Learn* 51), my question is whether the type of conceptual change that is characteristic of synthesis and sought as a goal of transfer theory can be identified, studied, and taught with any measurable consistency? This is a question that weighs heavily on synthesis pedagogy when synthesis is defined at the conceptualization level of critical thinking and writing behaviors. As Segev-Miller and other scholars have pointed out, concepts and conceptualization are core elements of constructing meaning via knowledge transformation (synthesis). Segev-Miller cites Spivey’s definition of discourse synthesis to explain the role of the *structural* component in representing and transforming knowledge: “[w]hen summarizing a text, students frequently replicate its structure” but when asked to synthesize, students “are required to create their own macroproposition . . . from different—sometimes even contradictory—macropropositions of several source texts, and to organize these in a previously non-existent conceptual structure (“Writing From Sources” 6). As available research within our field and anecdotal lore suggests (e.g., *the Citation Project*; Spivey and King; McGinley; and others), student writers are struggling to do this; I suggest that it is the way students construct mental and text-based structures when synthesizing knowledge is a problematic area that invites closer scrutiny when tackling the question of synthesis-related cognitive processes.

My study explores a cognitive-centered alternative to writing-from-reading methods commonly used to teach synthesis; therefore, I began this study by examining research that focused on how students *represent* their knowledge—both pre-existing and discovered—in their approach to synthesis construction efforts. In keeping with my premise for using concept mapping as a constructivist platform for students’ knowledge representation, a logical starting point is the concept of structure. Jonassen et al. point out that structures are essential to the

generative nature of learning and representation of knowledge construction when framed in terms of student agency (prior knowledge). Their breakdown of knowledge into three general types of structure—declarative, structural, and procedural—centers on the cognitive abilities of novice-to-expert learners in terms of how they are able to represent knowledge. Simply put, they explore much the same landscape as Bloom’s Taxonomy, but from an epistemological, constructivist lens that aligns with the methodological framework of this study. Jonassen et al. propose examining the knowledge construction practices of novice vs. expert learners in terms of “schemas,” or “ideational constructs,” which can be distilled into ways of both understanding the nature of and practicing knowing: (1) “knowing that” is *declarative*, or Bloom’s “knowledge,” (2) “knowing how” is *procedural*, or Bloom’s “application,” and (3) “knowing why” is *structural*, the conceptual foundation of the cognitive/metacognitive upper tier of Bloom’s taxonomy (Jonassen et al. 4-5).

Such epistemological frameworking of knowledge construction is highly relevant to my exploration of synthesis as an inventional cognitive process because it provides a theoretical foundation to my methodological choices. Specifically, it frames “knowing” in terms of not only procedural awareness (e.g., knowledge of conventions and skills), but also in terms that draw upon recent research in neuroeducation and cognitive sciences to examine the process of cognitive transformation. To study synthesis as an inventional cognitive process—and specifically to examine why and how (and where) transformation occurs—requires different strategies and resources than current composition materials and scholarship provide. This corresponds to Segev-Miller’s assertion that “little is known about . . . transforming strategies” other than summary (“Writing From Sources” 6). Also relevant to this point is her conclusion that very little has been written on pedagogies that “promote intertextual

processing” strategies as opposed to summary writing as a means of student engagement with textual information drawn from sources, especially as studied within actual classroom environments (“Cognitive” 231-232).¹⁵ This intertextual processing is a highly complex cognitive behavior that depends on an ongoing, recursive “interaction” taking place between “the ongoing composition,” source information, and prior knowledge, transforming all to create an “intertext” (Boscolo et al. 422). Such transformational processes are learned inventional behaviors, yet, as Lauer asserts, writing studies’ focus on the rhetoric of invention has been geared toward a study of content knowledge building, but without *transforming* “inventional strategies in the classroom” (“Rhetorical Invention” 3). As part of engaging this gap in my study’s methodology, I find it productive to explore synthesis pedagogies that move beyond the summary-compare heuristics commonly found in readerly approaches (Segev-Miller), shifting to frameworks that apply a lens of cognitive representation to progressive visualization of knowledge building in a DCMAP.

Such emphasis on areas of synthesis pedagogy and inventional theory feeds into one of the premises of my research project’s design, specifically the role played by representation and mental models in the invention process (Zhang and Patel). Using these as a way to promote active engagement in our research writing curriculum may contribute to “shift[ing] the authority toward the writer,” a move that Medvedeva and Recuber argue can be successfully facilitated by integrating concept mapping into argument instruction (139). Because concept mapping employs visual representation of thinking, the created paths provide an individualized model of students’ invention processes and artifacts. This type of rhetorical empowerment is valuable to an inquiry-based approach to writing and writing instruction (Bizzell and Herzberg; Brent; Bizup).

¹⁵ Summary is often included as a rhetorical strategy employed for synthesis tasks, but as Segev-Miller points out in her research, it is often mistakenly combined with another strategy—listing—and confused with synthesis.

Therefore, interventions that integrate more extensive training in conceptualization strategies, such as moving along the tiers of Jonassen et al.'s knowledge types to scaffold processes and practices from knowledge to conceptualization to representation, may also facilitate developing cognitive transformation strategies.

In their article “From Conception To Performance: How Undergraduate Students Conceptualise and Construct Essays,” Campbell et al. argue for the value of concept maps to achieve this goal, observing that too often theories seem to set up a restrictive binary, focusing too much “on the contrast between the organisation of knowledge as discrete, serial elements to be remembered and reproduced” or what Jonassen et al. called declarative knowledge, and the “*integration and transformation of knowledge into a personally constructed and meaningful entity*” as procedural and structural knowledge (Campbell et al. 449-450; emphasis added). Like the types of binary terms often used to discuss invention (Lauer *Invention*)—discussed later in this chapter—this too directly impacts students’ views of their own learning thanks to the instructional interventions that emerge from such theorizing. In other words, if instruction casts invention as an informal prewriting strategy rather than as an ongoing creative process of knowledge construction, students will likely be limited to that view. Our field’s current priority of training students to practice active metacognitive engagement requires we expand our interventional repertoire to include constructivist-based strategies that cover the *entire* construction process, from internal mental conceptualizing practices to externalizing practices of knowledge synthesis. Campbell and her co-authors argued in 1998 that students’ conceptual learning processes and the strategies they employ in writing have been largely under-researched (449). This limitation seems to continue; while there are a host of writing studies that examine learning and writing processes, it is difficult to locate examples within our field of studies that

focus on the *cognitive* strategies and processes involved in *conceptualizing* (Segev-Miller and Mateos and Solé are two examples). This despite the reality that *concept formation*¹⁶ is a necessary cognitive step toward synthesis that begins with mental representations of the assigned task (Medvedva and Recuber; Jonassen et al.; Segev-Miller; Flower et al. *Reading-To-Write*). One possible reason for this may be based on the question of how to measure cognition in an empirically reliable way; “seeing” cognition happen at the neurological level is not possible in ways that might translate into effective instruction. However, Flower and Hayes’ multiple representation theory includes an argument for “a conceptual tool” that will allow students to construct meaning not just on paper but all along the larger landscape of the process—from mental schema to structural knowledge (*The Construction* 97-98). Having student writers engage in actively creating connections using a concept map’s affordances may provide more than the performance of metaphoric building. It may provide an opportunity for reflective agency that promotes “[a]wareness or metaknowledge of one’s own representation, of the process that produced it, and of the forces acting on that process” (Flower et al., *Reading-To-Write*, 14).

Concept Maps & Synthesis

The question that prompted my research, simply put, is “Why do our students struggle with the concept and practice of synthesis?” That question informs my methodology and study’s design because any intervention worth its salt has as its core goal to aid students in their efforts to construct meaning by navigating abstract concepts like knowledge transforming. Using a design-based research approach allows me to consider this question as a means to identify a gap in current pedagogical methods for teaching synthesis. In doing so, the question might also be

¹⁶ Concept formation, as defined by scholars of cognitive psychology like Ausubel and Piaget, is a process involving direct observation and experience—a discovery process not unlike rhetorical invention (Novak “Ausubel’s Assimilation Theory” 406).

worded thusly: why do students struggle with how we *teach* the concept and practice of synthesis in FYW classrooms? To answer these questions, I focused on the interventions and their theoretical bases, and, given the number of scholars bemoaning students' synthesis writing abilities, concluded our pedagogy would benefit from exploring different approaches. Any discussion of cognitive models and processes inevitably suggests metaphors like networks or mapping. As Lakoff and Johnson famously write, "metaphors . . . structure the ways individuals conceptualize" (67) or, in other words, "give meaning to form" (126). As mapping and maps are familiar concepts to students, creating a visual-based representation of students' knowledge building efforts using the mapping construct seemed a logical first step in designing a classroom intervention that would situate "learners as designers." The focus is on providing students with a constructivist tool and space to allow them to explore *how* they "put knowledge together" in ways that create "something new," as synthesis is often described in teaching materials (Bruillard and Baron 335). Education Science scholars like Ambrose et al. explain that "novice" cognizers typically rely on knowledge organizing strategies that are "superficial" because of the limited "knowledge organizations they have been exposed to, as well as limited experience constructing complex cross-connections and structures" (56). In other words, reliance upon organizing practices that use declarative rather than structural knowledge (as defined by Jonassen et al.) tends to result in superficial constructions that "do not lend themselves to abstractions" (Ambrose et al. 58). In this case, a mapping metaphor might serve an essential epistemological function: a map can "make sense of our experience" by providing us with structural similarities that we use to construct meaning (Lakoff and Johnson 152). When contextualized as a structural framework for meaning-making, the role of a DCMAP as part of a student's research process becomes more than simply recording existing kernels of knowledge. As part of learning to think

as a designer, students can potentially use the affordances of a DCMAP to create pathways of connections to construct new knowledge by combining associational and relational thinking that may reveal more complex cross connections.

When used as an active representation of students' agency in knowledge creation, this construction method distributes the "power" of knowledge structures and knowledge processes (Hylerle 13). Jonan Donaldson, an Instructional Design scholar in the field of Educational Technology, writes of a "learning experience design philosophy of building online and digitally-mediated courses in which technologies are used as Trojan Horses for emancipation through constructionist problem-based learning with an emphasis on learner agency, situating learners as designers, and focused tinkering" ("Travelling"). In other words, the familiar commonplace of mapping becomes a system empowered with the purpose of enhancing metacognitive engagement. By viewing the learning process as intentional (creating, interpreting), I employ concepts of active learning (what Donaldson calls "[c]onstructionist learning") by beginning "with the proposition that learning is most powerful when learners *make things of their own design*" (Donaldson; emphasis added). These student artifacts metaphorically (and perhaps literally) represent emerging mental models or schema of their *process* of construction that is meaning-making. These maps, as created using CMAPS' interventional affordances, might then be examined as artifacts that represent "tangible objects-to-think-with—tools of embodied cognition" (Donaldson).

When framed this way, the DCMAP becomes both a heuristic and hermeneutic intervention, drawing upon Young and Liu's definition of heuristic as "an 'explanatory procedure,' a 'way of moving the mind out of its habitual grooves, of shaking it loose from a stereotypic past'" (*Landmark Essays* xvi). I believe DCMAPs may create a space where both

heuristic and hermeneutic qualities are engaged in ways that allow me to explore the potential benefits of extending the approach to synthesis as *a way of thinking* (the why), as opposed to a composition of *genre-based artifact* (the what). In *Invention in Rhetoric and Composition*, Janice Lauer lays out varied underlying assumptions about these definitions that have informed modern theories of writing, pedagogy, and knowledge over decades of our field's scholarship, specifically in attempts to classify the concept's nature in binary form (*hermeneutics* vs. *heuristics*) as it pertains to issues of epistemology (*Invention* 8-10). Lauer suggests that invention teaching strategies are typically "heuristic" in nature (*Invention* 122), using "a series of questions, operations, and perspectives . . . to guide inquiry" (*Invention* 8). The "hermeneutic practices" of our pedagogy then serve as "a counterpoint" to heuristic strategies by focusing on the why rather than the what ("Rhetorical Invention" 10). Yet, as Lauer explains, the two concepts/practices are designed to work recursively, in cognitive and practiced symbiosis. Lauer's definitions provide me with a useful pedagogical framework because they allow me to frame synthesis as invention in terms of both interpretive *and* productive acts for the purpose of *both* "constructing and conveying knowledge" in both the DCMAP spaces as well as corresponding written texts produced by students (Lauer *Invention* 123). The affordances of the intervention as described above are made possible, in part, because a concept mapping heuristic is designed to do more than simply create an organizational flow chart that records gathered data. Instead, when theorized through the lenses of MBE, cognitive mapping, and rhetorical invention, it becomes a flexible space for visualizing and enacting new connections and structures—its hermeneutic role.

These variations also serve my study's framework because of the potential they create for discussing synthesis as an inventional *cognitive process* of knowledge creation. Flower et al.

have observed that “[w]riters *restructure* their knowledge in minor ways all the time at the bottom of the hierarchy when they make local transitions or see that two ideas are parallel or in apposition to each other” (*Reading-To-Write* 64; emphasis added). This is something also seen in the early phases of concept map construction, but it is important to note that simple restructuring is not the same as synthesis. Despite this, however, that erroneous equivalent does seem to correspond to what teachers often see in student writing *instead of synthesis* when students attempt to integrate source materials into their research writing, resorting to comparisons or contrasts of same/different, or simple summaries (knowledge *telling*) instead of knowledge *transformation*. A case study conducted by Mateos and Solé confirms this, observing that “rather than using strategic thinking to resolve a problem requiring the integration of diverse pieces of information around a structuring theme, the students engage in the exercise of ‘joining, connecting, etc.’ as an end in itself [i.e., restructuring], without an adequate representation of what the task really requires” (448). This may be due, in part at least, to characteristic differences between novice and more experienced writers in the way they organize knowledge in their own minds. In their discussion of understanding as defined by how students organize their knowledge, Ambrose et al. point to a significant difference in “the number and density of connections among concepts, facts, and skills they know” as represented by novices when compared to more experienced writers (49). A novice tends to create connections that are fewer in number and more in the form of a simple “chain of associations” that represents simply the “sequential access of information” (50). This may reflect a student’s inexperience in “develop[ing] the ability to recognize relationships among pieces of knowledge” (49).

On the other hand, a more experienced learner demonstrates “more complex and highly connected knowledge structures” that comes from the ability to “process information in coherent

chunks based on their prior knowledge and then use these chunks to build larger, more interconnected knowledge structures” (Ambrose et al. 51). In their study on the use of concept mapping as a learning intervention, Hay et al. asked students to reflect on and literally map the process they take to locate, analyze, and actively create associational and relational connections between their sources. In doing so, these students are “making learning visible” by using the affordances of concept maps employed over an entire semester in order to capture the recursive and reflective nature of the learning process (Hay et al.). Thus, students create opportunities to begin *conceptualizing* in terms of patterns to create hermeneutic discourse, not simply to restructure or organize ideas.

Of course, moving from simple restructuring to knowledge transformation is the ultimate goal of synthesis, and is acknowledged to be the most difficult writing activity for novice as well as experienced writers (Segev-Miller; Spivey; McGinley; Mateos and Solé). This difficulty, according to Flower et al., is typically characterized in terms of text complexity or cognitive complexity; their research study emphasizes the latter assumption is more appropriate if we are taking a metacognitive approach to learning and teaching (63-64). Their illustration of this complexity as often seen in students’ attempts to transform knowledge is represented along a continuum that is defined according to “the writer’s process rather than the text” (63). This continuum, they explain, ranges from “low transformation” to “high transformation”—as influenced by “prior knowledge, amount and complexity of information, and level of invention” (64, Figure 6). Such a characterization is also true in our field’s modern emphasis on pre-existing knowledge, transfer, and student agency. More recent writing scholarship like Segev-Miller’s study of discourse synthesis builds on this assumption, and her work answers Flower et al.’s call

for more explicit teaching of synthesis writing as a cognitive process, not simply a written construction (“Writing From Sources” 8).

Synthesis is also difficult to *teach* because it is more than a writing skill: it is a cognitive conceptualization and invention process. Neurocognitive researchers look at transformation in terms of concept formation, the difference between knowledge telling and knowledge transforming. This is where the extended use and space of the DCMAP is key, as it allows students to develop a prolonged conversation over time through the use of recursive reflective activities in coordination with the map’s construction (Kellogg and Whiteford; Merrill 2002; Spivey and King 1989). It also creates a cognitive offloading opportunity that may assist students with tackling such a difficult cognitive task as synthesis. Kellogg and Whiteford’s study of developing writing expertise focuses on the cognitive benefits of taking our time to make the transition from being a knowledge teller to a knowledge transformer—an intentional agency—grounded shift in identity (Kellogg and Whiteford 118). While the reading-to-write approach to synthesis, as described by Spivey, is not theorized as a linear “first read then write” practice, our writing pedagogy is often designed to teach it that way (see, for example, Purdy and Walker; Bawarshi; Hairston; Hood).¹⁷ This gap between our field’s theoretical body of work and classroom praxis is one area that further reinforces the purpose of this study to reexamine how synthesis is *taught* as well as *learned* in first year research writing courses. To this point, student maps become an artifact for deeper examination of any possible changes that might suggest the occurrence of meaningful learning (Ausubel), as well as address questions about the transferrable impact of the mapping practice on student writing. One such possible impact made possible by the DCMAP is the creation of traceable associations (Latour; Spinuzzi; Villalon and Calvo),

¹⁷ This observation is developed more fully in the Introduction.

moments of metacognition taking place in the process of constructing the map such as use of features and reflective explanations of the process in journaling.

The importance of creating interventions that facilitate a “slow pace” is also raised by Emig in her 1977 work “Writing as a Mode of Learning.” In her discussion of what “successful learning” looks like, Emig points to interdisciplinary research which supports her notion that such “slow” processes are vital in the case of “the processes of analysis and synthesis” (127). Her observation that the *connections* allowed by “the shuttling among past, present, and future” of a writer’s “experience to make meaning” (127) is actually a node where the work of composition scholars intersect with later work in cognitive science to explore the role played by short-term memory in learning, task representation, and activating prior knowledge (Merrill). While Emig was referring to writing rather than concept mapping, her comments suggest that invention *needs* to be seen in its full rhetorical potential, and treated as such when we design interventions like digital concept mapping to provide the needed scaffolding space where students can grow from novice toward expert. This is more deeply explored as it relates to concept mapping in the Analysis chapter of this study.

Branch 2: Rhetorical Invention & First-Year Writing Classrooms

The second branch of my literature review explores the influential scholarship from my field of rhetoric and composition, with a particular focus on the first-year writing classrooms engaged in research writing.

The Freshman Writer: Novice vs. Experienced Cognizer

Over my years of teaching first-year writing courses, I routinely encounter student research papers submitted for assessment that fall short of academic expectations for writing. Setting aside issues of grammar or clarity, the most common practice with which students seem

to struggle is the incorporation of source texts in support of their own ideas as part of their persuasive research assignment. Part of this is no doubt the type of “novice writer” struggles discussed by Sommers and Salz in their 2004 essay, “The Novice as Expert: Writing the Freshman Year.” Such research focusing on student agency is an important hub of this literature review because it represents a significant trend in recent decades within our field’s theoretical discussions of student knowledge in terms of pre-existing knowledge and information literacy. In many ways, freshman writers *are* novices to the type of writing strategies called for by higher educational assessment goals, caught in the web of what Bartholomae characterizes as “inventing the university,” where they must “learn to speak our language . . . to try on the peculiar ways of knowing, selecting, evaluating, . . . and arguing that define the discourse of our community” (623-624). This process of “becoming” is especially problematic when students are asked to *perform* as researchers (Purdy and Walker), a role that they must grow into but at the same time are expected to practice “trying on the discourse even though [they do not] have the knowledge that would make the discourse more than a routine” (Bartholomae 625). This approach seems to put the cart before the horse, pedagogically speaking, especially in terms of prioritizing learning writing skills over those of conceptual invention.

An area where this “novice-as-expert paradox” (Purdy and Walker 131) is most noticeable is that of synthesis, in which freshman writers are required by academic expectations to demonstrate or practice the types of writerly moves typically practiced by “master builders while they are still apprentices” (Sommers and Salz 131-132). Given our field’s current attention to the role of students’ pre-existing knowledge in studies of transfer, it is troubling to consider Purdy and Walker’s 2012 charge that our very own pedagogical tools have the tendency to dictate and “construct” students’ identities and agency in ways that may actually run counter to

our core theories of process and agency—especially student perception of their own knowledge (9-10). For example, in their work *Writing Across Contexts*, Yancey et al. recommend students create “theories of writing” through reflective writing based on pre-theorized “key terms” in order to “help students think like writers” (4-5). They recommend providing students with these key terms in a scaffold approach to learning to produce what they call “conceptual grounding” (35). However, I believe this may be a problematic approach to agency-building, asking students to operate cognitively within a framework of accelerated concepts like exigence and knowledge without prior experiences to help them contextualize and personalize such abstractions. By imposing vocabulary of the field onto novice students in ways that Bartholomae may never have imagined, instruction that imposes ready-made conceptualization upon students as a substitute for student discovery (agency) may well guide students into practicing with these concepts (to “think like writers”) reproductively rather than cognitively.¹⁸ Hay et al. even go so far as to worry that research into the impact of prior knowledge (and, by association, student agency) on learning and teaching suggests that if such conceptual structures and terms are “inaccessible to students,” instruction may actually fail to “engender understanding among their student audience. In such cases, students learn by rote . . . or resort to other resources” (300).

Especially in the first year writing research sequence, Purdy and Walker argue “that prevailing approaches to research instruction in introductory composition courses, as represented in print and digital instructional materials, reflect outdated theoretical views and may damage students’ researcher identity” (10). Indeed, when examined through this lens, our field’s current

¹⁸ This is not unlike critiques of cognitive mapping use in classrooms in which instructors provide students with pre-made nodes and connections. Kozminsky et al., Nesbit and Adnesope, and others discuss the differences between providing students with pre-constructed map structures (limiting agency) vs. student-generated map structures (promoting agency).

approach to students' roles as novice researchers—especially in relation to agency and student voice—seems to be an area where we still have work to do.

This is where rhetorical invention and cognitive-based approaches to learning may provide guidance. Marlyn Cooper, quoting Bruno Latour, connects these views of student agency to our work in composition classrooms in a provocative way:

What if writing teachers and their students thought of research as empirical and experimental—as producing new knowledge, not reporting what is known? What if they thought of the facts they discover as provisional, part of a trajectory of knowledge, and not as final truths? What if they thought of the readers of their texts as colleagues who provide necessary validation of their facts, not as editors? What if they thought of their goal in writing as the direct perception of reality, rather than as defending a point of view? (193)

So if we look at this through Latour's lens (for the sake of the novice learner in first year research writing courses), then the experimental interventional spaces of a DCMAP used by students to performatively map out their actual production processes might become—by its very nature—discovery, a core definitional quality of rhetorical invention.

It seems to me that the *performative process* of moving from novice to expert is often left underexplored by scholarship in our field, and especially when it comes to the process of developing the higher-order critical thinking behavior of synthesis. This concept of novice vs. expert has particular relevance to my study because it allows me to situate student thinking practices *prior* to writing as a site for observation when the pedagogical intervention is an object of study. My students routinely express reluctance to project themselves through their writing as authoritative experts, thereby affording more time and in their thinking processes to the voices of their sources in ways that produce quotation-heavy documents. Howard, Serviss, and Rodrigue refer to this result as “patchwriting,” an act of substitution and reproduction for their own take on the subject matter (“Writing From Sources” 179). In her summary of lessons learned from the

Citation Project's research, Sandra Jamieson observes that "[w]hen students are new to a topic, they often don't know what information is important or how different pieces of information relate to each other. Everything is given equal weight. Without the benefit of experience, students overestimate or underestimate the importance of a single source and have difficulty synthesizing sources to see the 'big picture'" ("What the Citation Project" 132-133).

Jamieson's comments point to the exigence of my research study: students' struggles with synthesis writing. Our role as composition instructors involves developing interventions that effectively guide students in their growth toward developing progressively "expert" behaviors. The challenge this study undertakes is to *design* a classroom intervention that addresses their difficulty by focusing on the *cognitive processing stages* of synthesis: the thinking that happens *prior to* as well as *during* synthesis writing as part of their complex cognitive efforts to "see," and then create their own place within, a conversation of voices. In their study of student citation practices in writing research, Howard, Serviss, and Rodrigue note that when students are asked to "writ[e] from sources," they often fall back on practices of novice or "inexpert critical readers," substituting sentence-level patchwriting for deeper critical engagement with source ideas (178-179). Of course, as academic writers, most of our students *are* inexpert in the discourse of scholarly research at this stage of their education, and this becomes especially challenging when we ask students to synthesize information as part of the freshman composition course research project.

Cognizers: Tellers or Transformers?

Part of this challenge is students' perceptions of themselves as "knowledge tellers" rather than "knowledge transformers" (Kaiser Lee). Linda Flower, in her technical report *Negotiating Academic Discourse*, illustrates this difficult gap in self-perception, observing that "[e]ven

though many freshmen are familiar with academic writing from high school, the demand actually to enter a community as a contributing member can require important changes in students' image of writing and sense of authority, as well as changes in their strategies for creating text" (224). One such example of this happening is found in the student writing examined by *The Citation Project*, in which Sandra Jamieson finds students often resort to "a checklist mentality" in place of trying to construct new knowledge emerging from their research efforts ("What the Citation Project" 117). This type of "checklist" approach to new knowledge—where students simply follow a rote set of guidelines or forms—may be a lingering byproduct of scaffolding heuristics used in high school, as well as those used in college writing courses to acclimate freshman students to academic writing processes and expectations. As first year writing instructors, we routinely observe that students may resort to patchwriting and heavy reliance on quoted matter (telling) in place of interpretive integration of ideas (transforming), the goal of many assessment guidelines.

An alternative explanation may be more appropriately framed in terms of how students approach the complex nature of conceptualizing abstract cognitive moves like synthesis. Andrea Lunsford argues that this mentality is actually based in students' *cognitive* processing strategies, specifically the "level of cognitive development which would allow them to form abstractions or conceptions" ("Cognitive Development" 38). Grounding this discussion of student source use in discussions of cognitive development seems highly appropriate given our field's readiness to use such labels as novice and expert in our theory and pedagogy work. It becomes significantly valuable when synthesis is framed as something more complex than source integration/use or a writing product, phrasing commonly found in many composition textbooks (Segev-Miller; Kaiser Lee; Williams; Reynolds; Welch). Even though Lunsford's article is focusing on Basic

Writers, her description of “the relationship of writing and the processes of analysis and synthesis” (38) certainly correlates to the role of novice assigned to all of our first year writing students tasked with writing with sources as part of a research project. Anne Becker, in her review of writing models, asserts that lack of planning as part of these processes is a characteristic of novice or inexpert academic writers (25). This may suggest there is a need for an intervention that asks students to reflectively practice more on the cognitive level of *what takes place during planning*. Put another way, students struggle with synthesis writing because it is a complex cognitive performance of *concept building*, one that even fairly seasoned students have difficulty mastering (Segev-Miller 2004). Yet our pedagogy often focuses more on the building of text than cognitive development and experience in that process of building. This is where a review of key concepts drawn from MBE may be used here to frame my approach to this study, as well as to my reconceptualization of synthesis pedagogy.

Teaching & Studying Synthesis Using DCMAPS

Early in my research, several questions of pedagogy and learning influenced my study’s design, specifically questions on how our field’s scholarship reflects varied definitions of the nature of synthesis. (1) Is it a tool for our assessment of students’ correct and honest use of source materials? (2) Is it a written artifact or curricular outcome delegated to serve as a precursor step to the larger goal of the research essay? (3) Is it the complex cognitive, inventional performance of *processing* that occurs as an essential progenitor to writing? Based on my review of the literature, it seems our field relies heavily on the first and second frameworks, while more recent scholarship (performed largely outside our field) employs the third lens to examine the mental model building that occurs “behind the scenes” of creating a

written task. This cognitive performance of model building is a phase that seems often underexamined in composition research into instructional intervention design.

While our field has much to say in recent decades about *teaching* the research process—and synthesis is commonly seen as a stage of that larger goal—it has often been framed in terms of information literacy behaviors. Discussions of interventional practices and scholarship on the first year research writing classroom reflect this; works most often cited as examples are studies related to the Citation Project and Project Information Literacy (Head; Jamieson; Kaiser Lee; Kellogg and Whiteford; Segev-Miller “Writing From Sources”). However, some in our field do take a more rhetorical approach, such as Joseph Bizup’s BEAM intervention. His instructional method is based on a student-centric point of view to train student writers to “see” sources through a rhetorical lens that begins with students’ expertise rather than the absolute authority of extrinsic knowledge (Bizup 75). Rather than framing sources as objects to mine for parts, Bizup’s approach asks students first to account for their preexisting knowledge, and then ask what types of information they need to support their own ideas: Background to contextualize, Exhibits of ideas in action, Analysis opportunities, or Models to emulate (75-77). This rhetorical focus, argues Bizup, emphasizes what rhetorician Mailloux calls the “effects of texts” to help student writers’ frame their researched efforts as “objects of *interpretive* attention” (Bizup 40; emphasis added). Such a lens highlights a hermeneutic, rather than heuristic, nature of rhetorical invention.

Even so, the very terms we often use as part of our instruction and assessment may still convey to student writers a more prominent focus on the source knowledge as the ultimate object of emphasis when teaching synthesis writing. Several scholars have noted that concepts of locating, citation, and use occupy significant portions of textbooks and research projects

(Knobloch; Head; Sutton; Sunderbruch; Reynolds; Purdy and Walker). This can be problematic considering we are asking students to see themselves as creators of new knowledge by creating conceptual connections, even before they fully understand the nature of “concept.” While strategies for locating sources is a vital component of teaching research writing, the process for teaching knowledge-making is less consistently developed, perhaps because it is a more abstract process and therefore more difficult to teach. In their discussion of the connection between teaching practices and students’ development of a researcher identity, Purdy and Walker observe that “[i]nstructional texts provide a focus for the institution’s desire to control and direct students’ movement into the established practices of research that academics (and academic disciplines) use to construct students’ knowledge making, their learning spaces, and themselves” (12). In her work on student voice in academic writing, Bondi agrees, saying that students’ approach to their *own* powers of knowledge creation—even what counts as knowledge at this level of writing—can be directly related to instructional materials as well as the theory that informs their choice.

This leads to my call to recast the inventional concepts we employ in designing interventions for synthesis instruction in ways that do more to foreground the student’s role in this invention, starting with the cognitive processes of knowledge making. Rhetorical scholars like Doug Brent echo this; his work on reading as an act of invention emphasizes the power of approaching research as an inventional act of “knowledge construction” (*Reading* 105). Yet most of the instructional materials deployed in classrooms in the form of teaching texts still rely on language that continues to position “the knowledge-making practices of the academic discourse community itself” in ways that, according to Brent, reinforce a “sense of univocal recapitulation of received knowledge rather than true engagement in knowledge making” (“Writing Classes”

10). In terms of synthesis pedagogy, it may be that the theory that grounds our field's current approach to defining and teaching synthesis in the first year research writing classroom as artifact/outcome or tool of assessment runs the risk of inadvertently diminishing students' powers to make knowledge and meaning. By constructing interventions that assume a non-novice ability to recognize and conceptualize abstractions of knowledge, we risk forcing students into patterns of familiar practices to compensate for inexperience—often resulting in *telling* rather than *transforming* knowledge. What might change if we explore synthesis-as-cognitive process through a lens of Rhetorical Invention?

Synthesis as Cognitive Process of Invention

I believe our field and our pedagogy have reached a point when we can benefit from a different approach to teaching synthesis in the first year writing course, one that returns to our field's extensive history of rhetorical invention as our theorizing model but also takes into account advances in cognitive studies related to learning and pedagogy. Prior to their 2009 publication focused on synthesis across a wide range of grade levels, Mateos and Solé assert that “synthesis tasks have not been studied to any great extent,” and most of those studies predate 2000 (436). In these more recent studies, many of them rely on earlier keystone works: Spivey's various work published in 1983, 1989 (with King), and 1997 on discourse synthesis/writing with sources, and Flower et al.'s 1990 *Reading To Write*. One of the more recent studies of student discourse synthesis practices is done by Segev-Miller in 2004, in which she examines only upper-level students majoring in education. She also calls for additional research, pointing to both the lack of and even flawed research on synthesis processes as conducted by some scholars who “did not look at their subjects' rhetorical strategies, but rather at their rhetorical purposes, which, they argued, were determined by the subjects' task representations” (“Writing” 6). In her

work on cognitive processes, Segev-Miller points to others' criticism of the limitations of available research on synthesis in terms of both *what* has been studied and *how*, citing Martinez and Martinez's assertion that "[r]esearchers' methodology is seriously flawed when essays alone are used to assess students' capacity for thought. The common method of analyzing essays as though they provided a direct measure of cognitive processes ignores the myriad affective and situational factors which can influence learning outcomes" (3-4). Such limitations are important gaps to address in my study because their shared focus in terms of their object of study points to the expansive nature of this problem, crossing boundaries of both disciplinary knowledge as well as pedagogical applications. To help me explore the use of DCMAPs in a freshman research course, I rely on Janice Lauer's foundational work on the theories and practices associated with rhetorical invention, along with recent inquiries into active learning and agency through cognitive and educational science scholars to examine how students practice representation as part of their learning processes (Mateos and Solé 447). This is a perspective of synthesis explored by cognitive scholars as well as educational researchers like Mateos and Solé and Segev-Miller, providing me with productive connections between the cognitive and the rhetorical for designing my study's intervention.

It is important I note here that while some tertiary research on student synthesis writing does exist, the focus is often limited to multilingual students (Zhao) or as a byproduct of information literacy practices in research writing assignments (Zarefsky; Sutton). In her study of the freshman research paper assignment posted to the *Composition Forum*, Cara Hood points to synthesis only in terms of assessment outcomes, not actual student processes. Lundstrom et al. examine student synthesis as an information literacy skill from the lens of the instructor's pedagogy and assessment needs, not an exploration of student beliefs and thinking processes.

Lundstrom and her colleagues conclude that “more research is needed to explore alternative ways of measuring” synthesis as a “skill” as well as “a continued need for teaching synthesis” as well as revised interventional approaches and mechanisms (74).

This points to yet another gap in available research: how do we *teach* synthesis? Without becoming lost in the separate and often politicized discussion of how teachers of composition are trained, our field needs to explore more deeply theorized approaches to explicitly teaching synthesis. Anson’s observations about this process of theory-informing-practice best summarizes why: “most teachers of composition [are] not leaning heavily on the results of empirical research; instead they [are] informed by practitioner-based advocacy” (221). While such a “lore-based” approach to teaching what for many may be internalized knowledge is valuable and common practice, experience in the classroom is too often minimized in empirical research studies. However, a deeper understanding of the cognitive moves required in synthesis writing may promote more effective interventions and support of “what already works.” For example, my research questions ask if the affordances of an intervention like DCMAPs might allow students to literally and actively *create* an emerging “big picture” of their knowledge building behaviors. Drawing from recent work promoting metacognition through pedagogy (e.g., Yancey et al.; Campbell et al.; Hay et al; Winslow et al.), I found it helpful to combine studies on pattern building from our field with both cognitive and educational science in my design efforts. By so theorizing my intervention’s design as a constructivist space, I hope to explore whether students are able to construct a linguistic and visual map of their own conceptualization process as a precursor to synthesis by visually articulating patterns of relationship-building markers via the digital concept map’s connectors, nodes, labeling, and other features.

Others have also called for more research into ways pedagogical theory shapes synthesis teaching. In 2019, writing studies scholars van Ockenburg, van Weijen, and Rijlaarsdam compiled a wide ranging survey (from K–12 to college) of published studies on synthesis intervention pedagogies. They, too, conclude that more research is needed on several fronts, including “what each individual process contributes to the quality of synthesis texts,” along with analysis of any impact interventional effectiveness has on that process and future instructional designs (421-422). While their attention to student processes is largely defined in terms of reading and writing, their discussion also extends into the cognitive realm in terms of “transformations” (303) and “conceptual learning” (300) as part of their examination of effective instructional designs. They indicate that their survey of instructional designs reveals an uncertainty in terms of whether the interventions examined in the literature effectively achieve the desired outcome of “transformations writers must make when synthesizing” (303). On this point, their call for additional efforts to design and study “new, evidence-based interventions” (304) creates a space for my own exploratory study of an interventional design, as well as pointing to a need for researchers to examine the process of *transformation* as part of any such designing.

However, such scholarship also points out a stumbling block in the form of the varying frameworks and definitions used by academic disciplines to define how best to teach synthesis as a practice. This lack of consensus may, in part, be due to definitional variations in treating synthesis as writing product or cognitive process, like van Ockenburg et al., Barzalai, Zohar, and Mor-Hagani. For example, van Ockenburg et al. surveyed cross-disciplinary interventional practices used to teach students “intertextual integration,” a term used to signify synthesis (979). It is troubling to realize that their work is largely focused on examining synthesis in terms of

educators' instructional interventions that lump together synthesis with summary and narrative as synonymous tasks (982). Such variability in terminology used for synthesis is apparently not uncommon, not unlike our own field's history of varying approaches to rhetorical invention. While van Ockenburg et al. observe that "[r]esearch on instruction of intertextual integration has been conducted in diverse fields such as discourse studies, disciplinary literacy, and digital literacy," it demonstrates a lack of "interconnections between these fields" (974). The unquestioned relationship between pedagogy and student learning may suggest a reason for their other conclusion regarding students' lack of "motivation to engage in intertextual integration" (973). If students are asked to engage in synthesis work in ways that are framed beyond their own knowledge design experiences, and without explicit instructional interventions to scaffold the cognitive processes expected, it is not difficult to see where a pedagogy based on reading-to-writing processes alone may come up short.

Some international scholars, however, seem to be pursuing a train of thought similar to my own, especially with regard to the importance of considering the cognitive factors in student agency. In 2013, Solé et al. focused on reading and writing processes of elementary students in Spain, analyzing the textual products as well as reading and writing processes of students in order "to gain a greater understanding of the processes underlying synthesis production" ("Integrating" 75-76, 82). They also discovered that task interpretation may have played a role in observed results (83), referencing earlier studies that "concluded that the *cognitive operations* students engaged in were determined more by *the students' interpretations of the tasks than by the tasks themselves*" (83; emphasis added). This leads to their call for future research and pedagogical interventional designs to "pay more attention to students' interpretations of tasks" (83). Solé et al. point out that "[s]tudies in this area often analyze written products without

considering the fact that they are the result, not only of writing, but also of reading and *frequently omit to look at the processes involved*...[which] implies tacit acceptance that the product faithfully reflects the process” (85; emphasis added). They conclude that any future research, to be fully relevant, must also take into account “*the conditions* that promote an epistemic use of reading and writing” along with “*the processes involved*” (85; emphasis added).

In an effort to occupy this gap, my study attempts to approach synthesis research through a different—though familiar—lens: rhetorical invention. My reasoning for this approach is based on a number of potentially fruitful theoretical parallels. Rhetorical scholars Atwill, Lauer, Liu, and others have all called for compositionists and our field to revisit our relationship to rhetorical invention. Their works highlight the complex and dynamic ways our discipline has engaged and translated this core rhetorical practice.

Rhetorical Invention & Our Field: An Overview of Definitions & Trajectory

Rhetorical invention has been extensively traced as both theory and practice through the history of rhetoric and composition, shifting in importance and in function through multiple phases. As this development’s scope is so well documented by other scholars (Lauer; Atwill and Lauer; Crowley; Young and Liu), I will not reprise its entire journey here, but instead follow the model set forth by Atwill and Lauer, and focus my attention on the literature covering the tensions in invention theory and teaching practices that emerged with the Process Movement in the 1960s (Lauer *Invention 2*). This is not a haphazard choice; the emergence of cognitive theory in parallel with the rise of the process movement provides me with the genesis of critical intersections and terminology at the heart of my research project. This period of the literature also brings into focus some important contrasts with classical rhetoric’s conceptualization of invention in ways that directly inform some of our modern theorizing and pedagogy.

Nowhere is this tension better captured than in Sharon Crowley's take on our field's extensive (and at times contested) relationship with rhetorical invention, specifically focusing on the epistemic nature of the concept. In her 2003 publication, "Composition Is Not Rhetoric," Sharon Crowley frames the essential nature of this pathway into synthesis research in her insistence that "it is rhetoric's attention to invention that differentiates it from all other practices and fields of study" and that without it, rhetoric "cannot survive." She doubles down on this red line by asserting "any theoretical discourse that is entitled to be called 'rhetoric' must at minimum conceive of rhetoric as an *art of invention*." Her call to arms for our field is aimed at what she asserts is the ongoing influence of the current traditional theory of rhetoric (and, by association, composition pedagogy) over modern composition theory. *Methodical Memory*'s recent reissue may signify our field's continuing concern with current traditional theory's persistent impact in areas of our theory and praxis, as evidenced in some recent scholarship that argues its continued influence over theory (Simonson) and even content in composition textbooks (Bondi; Welch; Knoblauch). Such concerns are certainly relevant to courses such as first year research writing, in which novice writers rely heavily on cues for knowledge creation from the instructional materials and interventions imbued with such theory.

It seems we find ourselves at a point in our field where we are more than 30 years past its professed "break" with current traditional rhetoric as a driver of disciplinary theory and practice, and yet our scholarship continues to grapple with student agency in freshman writing classrooms. While Crowley's argument targets the role of institutional priorities and textbooks as influences on our classroom pedagogy (*Methodical* 139), her thoughts relate to my interest in how our field does and should define invention as it relates to students as agents of knowledge creation in the process of inquiry and knowledge construction in research writing. Crowley's critique of agency,

even in a text originally published in 1990 and situated by current traditional and cultural rhetoric, hinges on an understanding of invention “as a private authorial exercise” that inhabits early stages of writing (Pell 179). While the process movement has mitigated this assumption in many ways, especially in peer collaboration, it seems to persist as an underlying warrant when it comes to framing synthesis writing pedagogy. For example, the reading-to-write approach to synthesis instruction favors instructional interventions located at the text construction level, not the cognitive processing that comes before (and during).

It is here where Atwill and Lauer’s work on the state of rhetorical invention in the field of composition provides context and important groundwork for my own research. In particular, they chronicle the almost cyclical nature of definitions that inform the value of invention within our field, especially as related to agency and knowledge as they connect theory and pedagogy:

the relationship between invention and the writing process, the heuristic function of invention as a kind of thinking that stimulates new knowledge, . . . the importance of classroom attention to invention, . . . and the consequential nature of invention studies for practice and pedagogy. (“Rhetorical Invention” 2)

Such diversity of associations plays out in the variety of scholarly efforts to define invention in terms of both theory and pedagogy. Janice Lauer describes this diversity in terms of a “Rhetorical Invention,” where varied interests in the subject of invention have “migrated” to and “shaped many other areas of theory and practice in rhetoric and composition” over the decades (“Rhetorical Invention” 2). Perhaps as a result of this dispersion, invention seems to suffer from a degree of neglect as an object of study within our field, except in terms of theory (see Simonson’s 2014 discussion), an observation made by Lauer as early as 2002 (“Rhetorical Invention”).¹⁹ Lauer posits this might reflect—or even be caused by—modern composition’s

¹⁹ A cursory search in JSTOR for applied studies of rhetorical invention in the composition classroom reveals only a few articles that acknowledge studying rhetorical invention as a heuristic in authentic classroom spaces: McGarrity and Crosby’s 2012 essay, for example, focuses on public speaking textbooks but not student writing; a number of

lack of a “unified theory” of invention (11). Yet Lauer believes such flexibility should not be seen as a deficit, for she believes it encourages multiple approaches to knowledge and inquiry (quite fitting for our field’s recent trends in cross-disciplinary writing instruction). However, this “freedom” also creates challenges for pedagogy; when invention remains outside our critical scrutiny, it may take on the substance of a familiar background noise, perhaps even to the point of being so deeply internalized by instructors of writing that it loses its hermeneutic dimensionality. In other words, invention—despite previous decades devoted to grappling with its meaning—seems to have become limited *in classroom* practice to prewriting. As one of five Canons of Rhetoric, however, rhetorical invention’s scope of application is so much more, yet much of that rhetorical creative dimension seems to be absent from classroom instructional toolkits. It is largely with respect to this influence on pedagogy that I am framing rhetorical invention in terms of the hermeneutic as well as heuristic nature of those debates to define it as an object of study. These debates might be categorized in a number of ways, but at their heart they seem to fall into two camps of inquiry: what does invention *do*, and *how* does it make meaning? My research would add a third dimension to this inquiry: *where* does invention happen?

To explore these questions, I am relying upon Janet Atwill’s and Janice Lauer’s *Perspectives On Rhetorical Invention* as a grounding organizational framework within which to explore these paths of inquiry. Their work characterizes the debates over time in terms of a series of binaries: (1) heuristics v. hermeneutics, (2) knowledge v. invention, (3) process v. content. The authors also cast the history of rhetorical invention along two theoretical paths: rhetorical

recent dissertations that examine invention and technology. However, Kelly Pender’s 2011 publication “Philosophies of Invention” concludes that modern studies of rhetorical invention predominantly approach the subject from theoretical grounds.

invention as a productive/creative art (a quality of classical approaches) and rhetorical invention as an interpretive art (a quality of some current approaches). As Lauer observes, over time a number of rhetoric and composition scholars have centered their debates around these divisions, debates which directly inform trends in classroom pedagogy and my own study's evolution.

Terms: Invention & Theory

A factor that complicates my examination of rhetorical invention, aside from the functional binaries, are the very definitions associated with our pedagogy and theorizing of interventions. As Lauer and Atwill clearly outline, invention as a concept has a long history filled with varied definitions, often as the result of shifting disciplinary interests and theories. As a result, according to both Anson and Lauer, our field essentially operates without a unified conceptual framework for rhetorical invention, both in theory and definition. These tensions are woven throughout the scholarship of the last 20 years of composition history but existed long before as well (Simonson; Lauer; Crowley). As such, they provide an extensive body of scholarly work that can be examined for inventional theories' contributions to our understanding of how, over time, our pedagogy and theory practices have informed student synthesis and knowledge production behaviors in the classroom. Because the contested nature of invention is often framed by this scholarship in terms of a duality, it is not surprising that evidence of pedagogy and student inventional practice reflects this uncertainty (Liu; Hawee; Atwill; Lauer). For example, Simonson points to the role played by a national conference of rhetoricians in the early 1970s (the National Conference on Rhetoric), who turned to a "socially oriented theory of invention," moving away from a focus on an individual creative source: "[w]hile associating invention with 'the generation of something new,' it also began to collapse distinctions, arguing that 'discovery, invention, [and] creativity [were] overlapping processes'" (305).

Young and Liu assert that this conflation is one of the problematic elements of our field's approach to theorizing invention (and perhaps the reason for its marginalization), the very terms used to conceptualize it. They observe that our modern treatment of invention has resulted in a problematic development of variant or synonymous terms as part of both our advances in theory as well as pedagogy, what Liu calls the "terministic trio" of discovery, invention, and creation ("Invention" 54). Such synonymous treatment creates an epistemological muddiness to theorizing that inevitably trickles down into pedagogy and praxis, as well as how we frame the role of students in the *techne* of the meaning making processes of learning to synthesize. These variants are especially noticeable in disciplinary literature focused on constructing curricular outcomes and instructional materials, such as the Revised Bloom's Taxonomy (Anderson and Krathwohl) and the NCTE Frameworks for Academic Success. The way such terms are employed within a writing classroom "shap[es] the way *discursive production* [is] understood" and often reflects a supposition that they have been "more or less synonymous dat[ing] back to classical antiquity" (Liu "Invention" 54; emphasis added). However, Liu asserts that using these three terms interchangeably is not only imprecise, it also creates a dilemma for students being asked to synthesize in the sense of "creating something new" from existing materials a la Bloom's Taxonomic ordering of synthesis and/or creation. Further, this supposition operating at both a theoretical and a praxis level reveals a "failure to think through what it means to invent" (Liu "Invention" 54), a failure that may begin with the pedagogical framework of the classroom into terms of process and content. Liu asserts that we need to examine the problematic nature of the terms "discovery" and "creation" as they shape our assumptions about knowledge and meaning making, as well as our pedagogy-informing theories of writing processes and content development.

Young and Liu offer my study a compelling “de-tangling” approach to these three terms, one which opens interesting pathways for exploring synthesis as a cognitive invention process. They critique using the terms “‘invent,’ ‘discover,’ and ‘create’ [as] synonymous ‘neighbor words’” (xiii), because in reality these terms are not synonymous at all. Rather, as Young and Liu argue in their introduction, they represent “three quite different orientations in understanding discursive production” that “privilege” very specific theories and epistemological biases:

To privilege *discovery* is to believe in a preexistent, objective determining rhetorical order whose grasp by the rhetor holds the key to the success of any symbolic transaction. To privilege *creativity*, on the other hand, is to emphasize a general subjectivity as the decisive factor in initiating and sustaining the writing process . . . Rather than continuing to form an interchangeable terministic trio with “discovery” and “creation,” “invention” has been redefined by many scholars to signify a uniquely rhetorical perspective on composing that subsumes both objectivistic and subjectivistic conceptions. (Young and Liu xiii; emphasis added)

In sum, the terms we use to define and teach the writing process to our students (especially if synthesis is to be informed by our understanding of invention) carry epistemological consequences for students’ understanding of knowledge and meaning making. Calling this “a practice without a system,” Arthos acknowledges rhetorical invention’s long history as a bit of a chimera, with each generation of rhetorical scholars and teachers simultaneously discussing and understanding the concept as both performance and theory. For novice writers, however, this can be problematic when this fluctuation between binaries informs classroom praxis and theory. As if to illustrate this, Lauer maps out a wide-ranging overview of decades of our field’s response to exploring these competing or intertwined theories, creating what seems to be a fracturing of invention’s purpose. While on the one hand this may demonstrate Lauer’s argument in “Rhetorical Invention” that invention continues to be a productive—if decentralized—area of study, it also problematizes how we use that theory to inform our pedagogy as they “posited multiple writer positions” (Lauer *Invention* 96). These

theoretical splits, however, also offer space for non-compositional, interdisciplinary contributions, as Lauer points out in her history. Such diversity of thought has offered pathways that resist the perceived binary of inventional theories, such as the “Rhetoric of Inquiry” promoted by Nelson, Megill, and McCloskey. I point to this scholarship in particular because of its response to “modern” epistemology’s bias toward a binary approach to discourse knowledge and knowledge creation. While their focus was scientific research, the approach recasting invention as rhetorical inquiry is reminiscent of some social constructivist compositionists’ (like Simonson and Lyon) calls to reclaim invention’s early rhetorical identity for a composition field whose theories and pedagogies focus now on issues of agency and metacognitive transfer.

Terms: Heuristic & Hermeneutics

As my study is based on an intervention, it is worth pausing to explore the field’s complicated treatment of these two key terms that serve as premises for my approach to invention’s use as a teaching and meaning-making strategy. Lauer best captures our field’s treatment in *Perspectives*, commenting that the field developed heuristics during the early decades of process theory “to help writers go beyond the known, to guide writing to create new understanding rather than to fill in the blanks of a mode,” characterizing invention *teaching* strategies as “a series of questions, operations, and perspectives used to guide inquiry” and to create or construct knowledge as part of discourse (*Invention* 8). However, she also notes with some concern that invention (and associated heuristic designs) continues to be “EDNA’s servant in many classrooms and textbooks, acting only to find material to develop types of discourse” (“Rhetorical Invention” 10). There are other rhetorical scholars, however, who explore invention in terms of its hermeneutic qualities, as a creation of knowledge happening through interpretation of existing texts. Lauer observes that “classical [rhetoricians] . . . gave priority to rhetoric as a

practical/productive/cultural activity” while “contemporary’ [rhetoricians] give priority to rhetoric as a critical/interpretive theory” (“Rhetorical Invention” 10). The latter view leans into imbuing invention with epistemological features that I believe form a potential point of unification when discussing invention in terms of cognitive processes. Lauer’s work in “Rhetorical Invention” provides a path forward in pursuing this bridge. Rather than positioning “hermeneutic practices” in an opposing position, Lauer argues counter to some rhetoricians’ views and asserts these are actually two parts of a whole, with the hermeneutic providing a symbiotic “counterpoint” to heuristic strategies to fill in the *why* to the corresponding *what* (“Rhetorical Invention” 10). Lauer points to some rhetoricians like Lynn Worsham who deepened this discussion by proposing the hermeneutic face of invention should be defined in terms of “not *what* but *how*,” and that writing is first “an event of disclosure” (Lauer *Invention* 92). This cultural situatedness of meaning making emerges as well in recent “social turns” of our field; critical cultural studies have appeared as an influential source for hermeneutic heuristics. As Richard Fulkerson observes, in the early part of this 21st century our field has “turned” again, this time toward a “social-construction” approach to composition pedagogy “which values critical cultural analysis,” as well as an approach he refers to as “procedural rhetoric” (655). He further breaks this social turn into twelve distinct areas of pedagogy, all of which assume the centrality of the “process perspective” (656-658) but have as their aim goals beyond simply guiding writers from novice/apprentice toward advanced/experienced in ability. This is important because such a framing device further demonstrates that these debates center on how knowledge is *made*, a question that drives my study of the interventions we use to teach synthesis as a knowledge making activity but not always as a knowledge making *process*.

I find that Bawarshi adds an interesting complication to this definition in terms of the role the individual writer plays in framing our invention pedagogy and theory. Like Lauer, Bawarshi argues that “rhetoric (and an understanding of invention based on it) remains marginalized in writing instruction” as a result of English Departments’ treatment of first-year writing courses (149). However, while Lauer asserts that the diaspora to which rhetorical invention has been “marginalized” can actually be a “promising terrain for future construction of multiple and rich arts of invention” (“Rhetorical Invention” 12), Bawarshi asserts that its marginalization (due to rhetoric’s replacement by composition in English Departments) has actually produced “an epistemology that has well nigh destroyed it” (60). He characterizes this epistemology by the move from a function based on public discourse to a “modernist emphasis on the individual mind as the locus of knowledge” (58). In other words, the writer is at risk of being understood as *outside* the conditions/context that give rise to that moment of discourse. To avoid this oversight, Bawarshi proposes we “re-place” or re-frame our current method of *teaching* invention by moving our *understanding* of invention “from the writer to the genred sites of action in which the writer participates” as a way of strengthening that connection between writer and rhetorical situation (149). In other words, in order to resist the theory of the “private economy of the writer as a self-possessed agent,” our invention pedagogy needs to teach writers to locate and adjust their thinking and writing within a system that might be described as more ecological in nature (60). Yet, how does this account for the need to help students conceptualize their own inventive powers as contributing to the existence of said genre?

I would argue that such a shift as Bawarshi proposes risks diminishing the *novice* students’ view of their own agency as knowledge *designers* (as both a productive and an interpretive behavior) in deferring primary agency to the larger rhetorical situation (a Catch-22

not unlike the Vatz/Bitzer debate). If students' *invention* possibilities are to be defined only by the borders of a specified genre (such as a source-based academic research assignment), and its related standards for operationalizing genre knowledge, how are they to work out their potential as creators of "new knowledge" (as we define synthesis) through inquiry? Such a view of invention as Bawarshi's—especially when it informs classroom synthesis pedagogy—might actually limit novice students' potential for developing meaning-making behaviors that allow them to invent by integrating prior knowledge with creative connections that might require crossing such borders. Cope and Kalantzis, along with Cross, Purdy, Donaldson, and others who promote a more constructivist approach to learning and pedagogy, suggest that taking more of a designerly approach to invention-as-meaning-making may address these concerns. In particular, as Donaldson points out, when pedagogy promotes a view of knowledge creation (invention) as transfer/acquisition rather than generative, the type of inventional behaviors students practice are more likely production/duplication than invention/creation.

Arabella Lyon takes up a similar concern about invention pedagogy, pointing out that such a shift may reflect a postmodernist tendency to treat rhetorical invention as an either/or: it is either hermeneutical in function, or productive. This division might then lead to a subsequent replacement of the productive with the interpretive, one which leads "rhetoricians . . . [to] diminis[h] the place of rhetoric as an action in the world" (Lyon 36). However, such dichotomous treatment neglects calls for a more integrative existence of these concepts, which Lyon expresses in form not unlike Lauer and Atwill's calls to "redeem" invention's rich complexities from modern theory and pedagogy. Lyon calls for a reclamation of invention from the interpretive (hermeneutic) approach fostered by postmodernism's influence on rhetoric to an approach that promotes rhetoric's productive frame. As part of her reasoning, Lyon argues that

rhetoric is too often thought of in terms of “textuality,” a holdover from our field’s roots in English Literature, as a literary, readerly approach to knowledge creation (36). To this point I concur, as it relates to common approaches to synthesis practiced as a reading-writing as opposed to cognitive activity. She writes that “[b]y turning toward interpretation [or hermeneutics] and away from production and making,” we would seem to position knowledge as established and externalized—a concern for Hawhee as well (36). As is often the case with binaries, I stand with Lauer in favor of positioning the two concepts as an integrated and interwoven operation, one that is integral to cognitive processing. In that way, student writers might be better positioned as knowledge creators if invention is defined through a combination of reciprocating lenses: as “maker” (heuristics), students’ actions are privileged as well as their own pre-existing knowledge in the process of discourse production. As “interpreter” (hermeneutics), students are granted the cognizer role of knowledge transformer, one that interprets experiences through connection and association—essential behaviors to synthesis.

Despite such complex theorizing of rhetorical invention’s place in writing pedagogy, invention continues to be limited in the classroom to a place of beginnings and heuristics. For example, some modern textbooks and scholars continue to define invention as primarily inhabiting the location of “prewriting” in the writing process, limiting the characterization of invention in terms of heuristic strategies commonly used as starter or “idea generating” steps early in the process (Anson “Process Pedagogy” 218-219). In light of this unsettled history as part of the groundwork of my own research, I am led to ask what role rhetorical invention plays in a classroom so theorized, and what “epistemological assumptions” are made as part of its pedagogy?

Like Lauer and Simonson, I believe this area of “tension” is actually an area of opportunity where, given interdisciplinary scholarship’s recent discussions of the cognitive nature of constructivist pedagogy, an opening is created for new studies of invention as an ongoing *generative* practice of distributed cognition.²⁰ For example, Simonson picks up part of my question about assumptions that drive our pedagogy in his discussion of recent attempts to modernize rhetorical invention as theory to highlight its generative heuristic features (303-304). His proposal to “re-invent invention” includes the generative functions of “inventional media,” which he defines in terms of material as well as practice and ontology (313). His work signals the contested nature and places of invention continue to be an active theoretical space for exploration in our field, while at the same time highlighting the lack of translation into pedagogical practices in the classroom. This is especially apparent in ways that feature the co-creative role of students in making meaning through synthesis practices.

While I find the emphasis on the civic and social nature of rhetoric as part of its exigence to be an important consideration when teaching synthesis as a cognitive process of invention, at times such debates seem to perpetuate the separation of the heuristic nature of invention from the hermeneutic. I find that Atwill and Lauer’s emphasis on the classical conception of invention as “art as a process and act of ‘making a path’” (Atwill *Perspectives* xx) appears to resist the potentially risky binary of privileging a type of knowledge that might reinforce the dilemma of novice vs. expert identity discussed earlier (Purdy and Walker). While any pedagogy risks privileging or “reinforc[ing] the ways of thinking and status of a particular knowledge” (LeCourt

²⁰ Here I am using Hutchin’s original concept of distributed cognition (*Cognition in the Wild*) as it is framed by Zhang and Patel, whose research into representation defines distributed cognition as a discipline “concerned with the distribution of information and knowledge between and across internal and external representations” (334). This view avoids potentially problematic discussions of mind-as-computational-system, and instead allows me to focus on the behaviors within that system in order to frame knowledge and cognition as an act of construction necessarily taking place across individuals and tools.

392), Atwill's characterization provides me with a more flexible lens when examining invention as a cognitive process, one which makes the students' role a priority in the constructive act of transforming knowledge that defines the creative function of synthesis. And while the voices of several modern rhetorical scholars, like Lauer, Atwil, Lyon, and Bawarshi, call for a "reclamation" of the term *invention* (37), there is no clear consensus within our field on what that should look like as it is applied in classroom pedagogy. Lyon's argument on how our field chooses to define invention as either practice or *techne/art* corresponds to our field's attempts to theorize pedagogy and praxis even in such scholarly conversations as WAC and Teaching for Transfer. This leads me to the next set of key terms in invention's history.

Terms: Knowledge & Invention (The "How" of Synthesis)

One of the challenges of synthesis faced by our first-year writing students is a question of epistemology: what does it mean to create "new knowledge"? From a pedagogical stance, how are we to guide novice writers in that process when, as pointed out in Liu's work, so much of our scholarship in this area emerges from concepts that remain contested in their meaning or application? Not surprisingly, the terms we as scholars use in our theorizing have a significant impact on ways that theory translates into classroom practice and textbook designs, in terms of both heuristics as well as hermeneutic assumptions. This is especially significant to my design choices for this intervention-based study of synthesis processes because of how those design choices become areas where student agency plays an active role in the intervention itself. It is also here that I directly connect to DCMAP scholarship and theories related to operationalizing the metaphor of mapping to enact and represent cognitive process.

I assert that synthesis, especially as taught in FYW classrooms, would benefit from adapting Liu's proposals when we consider the terms of *invent/discover/create* as *concepts* that

require deeper theorizing as we enact them as part of our lesson planning. Based on his reference to Derrida's call to desynonymize the terms given their linguistic particulars, Liu (59) deconstructs these terms and suggests we implement an alternative term—*inventiveness*—that would allow us to treat “creation and discovery . . . as two analytical aspects of invention, definable only in reference to the latter. I believe, as Liu argues, that doing so would go a long ways toward alleviating the novice writer's anxiety based on frequent calls to synthesize using the term of “create,” as in “original” knowledge (as alluded to by the language of Anderson and Krathwohl's revised Bloom's Taxonomy so often present in composition textbooks, as well as in our field's “Frameworks for Success”). How are students in a freshman composition course supposed to interpret that demand, given their new status as academic novices or apprentices (Bartholomae; Sommers and Salz)? The distinction proposed by Liu allows me to shift the concept of *create* to a design-based approach, where “new knowledge” is not construed as “original knowledge”; instead, it is the act of *techne* in play, creation as *performance*—through both the mapping process and engaging with the affordances of the DCMAP—drawing connections among a series of knowledges to *perform* the process of building as an on-going act of discovery as exploration (invention). I see Liu's theory as a reflection of our field's unease with rhetorical invention, and how it is often deployed through pedagogy, classroom materials, as well as expectations of student agency in synthesis writing abilities. It also facilitates further examination of why our field needs to grapple with the unquestioned placement of invention as an early “step” of the writing process, a move that would drain it of its complexity and rhetorical relevance for our FYW students seeking to transition from novice to experienced writers. Such a shift—and the necessary re-conceptualization of synthesis—could open opportunities to examine and explore students' cognitive processes as agency and knowledge building opportunities.

These are vital to any effort to adjust our pedagogical approaches to synthesis, as both concept and practice.

Terms: Process Vs. Content as Transformation (the “Why” of Synthesis)

These decades of uncertainty toward theorizing part of a rhetorical canon at the heart of so much of what we do in composition is at the root of so many of our discussions about classroom praxis. Lauer echoes my own premise when she asserts writing studies’ focus on rhetorical invention has been geared toward a study of content knowledge building, but without *transforming* “inventional strategies in the classroom” (“Rhetorical Invention” 3). Lauer and Atwill, among other scholars in the field of rhetoric and composition, categorize such uncertainties regarding the origins of invention’s plight into two groups: (1) questions of theoretical centrality or value, and (2) questions of functional definition. Lauer’s investigation into ways our field currently conducts research on rhetorical invention (at least in the early part of the 21st century) led her to conclude that most of the research “tended to be more focused on theory than practice,” resulting in what Atwill describes as a limited approach to the canon’s “fullest expression” in terms of its creative function or application (Atwill xi). Some, like Crowley, Hawhee, and Lyon, see this as a reflection of educational institutions’ power as manifested through “institutional values” that influenced compositionists’ curricular and pedagogical foci (Atwill xvii). That is, interpretive actions based on existing texts like literary works were the norm for departments in which writing instruction served the priorities of the traditional academic disciplinary needs, such as English/Literature. Such a charge certainly makes sense given the persistence of narratives that frame freshman research courses’ value in terms of preparing for “real” upper level coursework.

Despite the current emphasis on agency and metacognition in our field's major publications and conferences, Lauer's concern with the perceived imbalance in scholarship favoring theory over pedagogy research seems to persist, especially when it comes to the binary of process vs. content as an instructional goal. For example, Scott Consigny points to the works of Bitzer and Vatz on the agency-assigning role of the rhetorical situation in which invention takes place. Consigny's summary of the tension of this view as captured by the Bitzer/Vatz debate is based on the *location* of creative agency: Bitzer asserts the rhetorical situation *creates* agency for the writer, while Vatz asserts that it is the writer's agency that *creates* the rhetorical situation as an act of invention (59-60). Framed another way, for synthesis the question becomes one of instructional focus: do we want to privilege student process (and, by association, agency) in our pedagogy, or the academic content expectations? Consigny proposes that to resolve this conflict we need to theorize invention as an "art of topics," thereby equipping student rhetors with "devices" that help them "discover" and "make sense" of knowledge (67). This sounds very much like the unresolved epistemological nature of the heuristic/hermeneutic debate's impact that continues to affect our pedagogy and praxis, especially as reflected in the limited research on methods used to teach discourse synthesis (referenced earlier).

Other scholars like Ritter and Matsuda, along with Lauer, consider the effects of international as well as inter- and cross-disciplinary movements like WAC and WID in framing our field's theoretical treatment of rhetoric and writing, which includes studies of invention. Heilkder and Vandenberg refer to the "[m]ethodological plurality in the study of writing *practices*" as one result (xiii). Another example of this is the distinction made between composition studies and writing studies. Ritter and Matsuda define composition studies as a "subset of the larger field of rhetoric and composition," one that "draws insights from various

related fields in order to address issues in the teaching of writing” (1). Recently, scholars have been promoting the term *writing studies* as distinct from *composition studies*; Paul Heilker and Peter Vandenberg have edited two volumes of *Key Terms*, the first (*In Composition Studies*) in 1996 and the update *In Writing Studies* published in 2015. The editors felt shifts in the discipline warranted a revision of their text to reflect these changes, pointing to writing studies as a “newly imagined community” of scholars born out of composition’s “self-consciously struggling with its provincial origins” (xiii). Others, like Downs and Wardle, approach composition and writing studies as one and the same (Heilker and Vandenberg xiv). With such change, it comes as no surprise that our treatments of invention in such an environment necessarily invite a much broader (i.e., cross-disciplinary) theoretical lens in research and in classroom praxis, one that is not necessarily consistent in rhetorical scholarship. It seems illustrative that while the term *invention* does appear in *Keywords in Composition Studies*, it is missing from *Keywords in Writing Studies*, perhaps suggestive that its value as a part of “our disciplinary parlance” has been eclipsed by others deemed more significant in terms of “power, identity, and values” (Heilker and Vandenberg xvii). Finally, while many in composition share Ritter and Matsuda’s assertion that our field has always been, at its core, interdisciplinary (1), traditional assumptions about *rhetorical* invention’s purpose as art vs. skill have at times seemed to translate into a resistance to other disciplinary approaches to inventional processes (e.g., the mind as information processor) in favor of our own field’s current theories located in the social rather than the neurological (e.g., Fahnestock). Thus, it is perhaps not surprising that research into composition classroom practices and pedagogy focused explicitly on synthesis as an inventional *and* cognitive process of creation is sparse, making the composition classroom a logical site for my research into pedagogy and student cognition/agency as framed by rhetorical invention.

The shift from the current traditional to process movements in composition, while far from an accurate, “clean” representation of our field’s theoretical and pedagogical development, seems to represent the most recent location of invention’s ongoing “existential” crisis in our field. This shift is perhaps better characterized in terms of what Ritter and Matsuda describe as “waves of pedagogical theory, each providing a view of the student, his or her audience, and the written product in different relation to one another. These waves, like the history of composition studies itself, are viewed differently by different scholars” (5). One of these waves is the process theory of pedagogy as a reaction to (some would say a rejection of) the Current-Traditional Theory of writing. This transition is covered more deeply in others’ scholarship (most notably Crowley), and so I will only focus on the transition into the process movement of our field as it relates to rhetorical invention. Our field’s shift toward a theory of process brought rhetorical invention back into center stage, often as a site of contention or debate. In 1978, Young argued that the current traditional model devalued the art of rhetorical invention, creating a “crisis in our discipline” (401). Richard Young, a dominant voice in the discipline of rhetoric, saw the process movement as part of the solution to our field’s attempts to resolve that crisis, saying that “[i]nvention requires a process view of rhetoric; and if the composing process is to be *taught*, rather than left to the student to be *learned*, arts associated with the various stages of process are necessary” (401; emphasis added). Read today, Young’s statement points to a glaring variance in how *process* is *taught*, positioning the authoritative lens on the teaching process rather than the student’s agency in learning, which I argue persists in the area of synthesis instruction. Bawarshi’s proposed turn from individual students’ minds to focus on the importance of the “*site of action*” (149) reinforces this concern because it further complicates the student agency in

knowledge construction.²¹ Even while such scholarship remains in the domain of theory, the move into the process model of pedagogy continues to be problematic for invention as a topic of instruction. For example, recent studies that do explore the processes of synthesis learning and instruction rely heavily on reading comprehension—a commonplace for our field—rather than rhetorical invention (Mateos and Solé; Segev-Miller; Spivey and King). Once again, the binary choice model seems wanting if we are to acknowledge the importance of the cognitive processes involved in conceptualization and knowledge transformation, both essential elements to learning (and teaching) synthesis. This brings me to the discussion of *where* our theory and pedagogy positions synthesis (as cognitive invention) in writing process instruction.

The Where of Synthesis

A common view of invention positions it in terms of early stages of writing, a view I believe is limiting given the ways such a definition potentially directs pedagogy and frames teaching materials like textbooks as an early-stage prewriting skill. In his article, “Process Pedagogy and Its Legacy,” Chris Anson points to invention as *prewriting in process* in the sense of invention as “discovery of ideas” (218-219). He continues on to explore the field’s legacy with process as a shift in focus away from product/modes and deficit assessment (i.e., assessing student writing based on what is missing) (215). With this shift in pedagogical attention, there is also a “shift [in] the orientation of learning away from expectations for a final text and toward developing the knowledge and abilities needed to produce it” (217). Textbooks like those cited in research by Knoblauch, Horadan, Purdy and Walker, as well as books my own writing program has used and reviewed, commonly arrange chapters into steps, with invention predominantly

²¹ Of course, the question of how to “see” and study students’ learning leads us to observe what is most easily examined: textual artifacts, which logically begin with instructors’ authorship of heuristics and assignments. However, as I argue in this study, given what we now understand from research in cognitive processing and neuroeducation (MBE), these sites need not be so limited in our study.

appearing early in that sequence. Anson's article points to this unease with the limitations of process-as-theoretical paradigm as our field continues to refine its pedagogical applications (224–226). This perception may have its roots in the very study that came to characterize invention as part of the writing process: Rohman and Wlecke's 1965 study on prewriting, published in the early stages of the process movement. Their definition of this concept/heuristic is one that is replicated in numerous textbooks to this day, situating discovery as a prewriting invention practice, one that gives way to "real" writing development once put into textual form as "words onto paper" (106). Bawarshi argues that this also perpetuates an unfortunate perception of the writer/author as a "self-contained sphere of agency" (61), ignoring other facets of that writer's social sphere that inform that agency (thereby giving those actants agency as well). That criticism is similar to one levied at a corollary in our field's theory—the cognitive process of writing—developing during the same timeline as the process theory, along lines emphasizing individual student thinking processes (the mind). Bizzell and Faigley, like Bawarshi, found these cognitive-oriented theories of writing problematic because they ostensibly neglected the role and agency of discourse communities upon the student writer (Kellogg and Whiteford 110). However, as this tension reveals, such objections seem to reflect another binary-based assumption about invention's nature: *either* it relies on an agency that takes place in isolation (the writer's mind) *or* is an agency theorized as existing only within a network of other actants.

The problem with such theory building, as pointed out earlier, is that it often tends to privilege a perspective (and all its assumptions about novice writers) rather than an application. A possible exception to this is the concept of productive theory building as theorized by Louise Wetherbee Phelps. In an interview with Rodrigue, Phelps explains that such an approach to

theory is that it “affords or enables constructive action, building or creating anything” (“A Portrait”). Fortunately for our scholars and students alike, a rhetorical approach to teaching invention is not bound to one theory. As composition educators, we rightly draw upon theory to design teaching content, but even within invention’s diaspora remains the essentials of the rhetorical situation: writer—audience—message—purpose. As Kellogg and Whiteford argue in their article, “the assumption of the process approach is that the task of becoming an expert writer involve[s] more than mastering the nuances of a particular genre. It also involve[s] learning general procedures for thinking . . . that develop with growing expertise in the same way regardless of the domain and genre of writing” (“The Development” 110). Theorizing the location of inventional thinking, then—especially when it is conceptually limited within process pedagogy as thinking prewriting—is bound to complicate how and where we teach synthesis as a process.

This history suggests a site-based approach to rhetorical invention’s definition may also reflect on how we situate and conceptualize student agency and their synthesis writing practices as part of the process of knowledge creation. Hawhee points to Young and Liu’s observations on the duality of rhetorical invention’s definition in terms of objectivity and subjectivity, continuing on to explain “the distinction between these two hinges on issues of exteriority and interiority” in terms of epistemology and agency (subjectivity vs. objectivity) (16). She writes that “the discovery model presents a subject that looks outside itself to ‘find’ arguments, and the creative model assumes that the subject need only look inside itself for things to say” (16). This points again to a lingering theory-to-praxis bias that often reinforces the notion that the agency of knowledge creation lies with the external “new” expert knowledge gathered rather than the transformative internal (i.e., cognitive) student creative practices (Hawhee 16). Logically, such

theorizing will inform the heuristics used and “the processes [those heuristics] are designed to facilitate” within FYW2 lessons on synthesis (Young 199). For example, Young asserts that when the process of invention is informed by its definition as creative, heuristics employed for teaching must still operate according to a few basic assumptions about their function and processes. Thus, when students are asked to “create” knowledge in a generative sense, as they do in acts of synthesis, our choice of heuristics (and how they are theorized) should and will reflect upon the student writers’ composing processes. What we want students to do is treat synthesis *as* invention: discovering others’ knowledge results in creation by transformation. More than that, however, is the transformation of students’ perceptions of themselves as researchers and knowledge creators by experiencing what Hawee refers to as a “discursive encounter” that results in “forg[ing] a different subject” which in turn “becomes a force in the emerging discourse” (17). In this way, invention transforms the writers themselves when treating agency on a cognitive scale as well as a discursive scale. When seen in this light, the importance of considering the cognitive dimension of synthesis as a process is even greater. The question then becomes how best to design an instructional intervention that facilitates this dimension in ways that provide student writers with the opportunity to invest in its implementation. For my research, the DCMAP provides just such an opportunity, positioning student writers to become knowledge *designers* on both a cognitive as well as literal scale.

Taking the Cognitive Turn: Knowledge & Meaning Making

The influence of what has been called “the cognitive turn” in our field informs my questions about *where* invention happens and *how* it makes meaning. Lauer observes that a common denominator for all theories of invention exists in “studies of epistemologies and cognitive processes” (Lauer “Rhetorical Invention” 1). Invention theory work in our field in

recent decades directly relates to the ways in which we *conceptualize knowledge construction in the classroom* (what it is and where it is located), a question our field's scholars frequently ask about invention (Simonson 300). As our field knows all too well, knowledge is a contested topic in academic discourse, with conflicts ranging from how institutional values shape knowledge (Crowley *Methodical*), to the value awarded to students' pre-existing knowledge in knowledge creation, specifically true with respect to my research in synthesis writing sources (Yancey et al.; Kaiser Lee; Purdy and Walker "Liminal Spaces"). However, it is also the *origin and structure* of knowledge that invites scrutiny, and this impacts the way we frame and theorize rhetorical invention and discourse production as part of our classroom pedagogy and materials. *This* is where my study must move beyond the borders of composition theory and into other disciplines such as neuroeducation and cognitive science, a move which requires explanation. Atwill points out that critics of Lauer's advocacy for expanding the reach of writing teachers into interdisciplinary resources for teaching and theorizing pedagogy was the result of a dichotomous view of knowledge by some in our field in the early 1970s, for which there were "only two types . . . the humanistic exploration of value . . . and the hard, instrumental, scientific knowledge" (*Perspectives* xiv). This same tension played out in the era of the "cognitive turn," as exemplified by the exchange between Flower and Hayes and their cognitive writing process critics like Bizzell and Faigley. As is often the case with productive theory building (Phelps), critiques led to clarifications, and the "cognitive turn" in composition/rhetoric continued as the "cognitive thread" within our discourse community. One area where this directly impacts pedagogy is in designing interventions that highlight knowledge- and meaning-making processes and practices such as invention.

In his entry for “Invention” in *Keywords in Composition Studies*, Donald Bushman cites compositionists LeFevre and Brent as among the proponents of expanding the definition of invention into “a recursive, dialogic activity that one engages in during all stages of the writing process” (134). Such a dialogic approach to invention favors its definition as an act of inquiry to construct new knowledge, reminiscent of invention’s origins as “logophilic,” or “means of thinking” (Simonson 301). It also favors its definition as *techne*. A focus on the *techne* nature of invention, as explored by Lauer and Atwill, provides an opportune bridge here. Framing *techne* in terms of the cognitive invention process employed during synthesis necessarily highlights the power of students’ creative agency in seeking and making connections as a form of outward cognitive path building. This agency may also be manifested externally when students actively engage in meta-reflection on their own complex processes of construction, facilitated in this study as they engage with the DCMAP as a strategic “guide [to] a complex activity” (Lauer *Invention* 6). Thus, my decision to apply invention as art (*techne*) on a cognitive level in this way emphasizes this creative impetus, opening the way to make both theoretical and pedagogical parallels to synthesis writing.

Locating this discussion of synthesis within our field’s treatment of rhetorical invention also offers me a number of important and productive areas to explore this, the first of which is how synthesis becomes a space where the hermeneutic (interpreting the knowledge of texts) and the heuristic (how to produce texts that create knowledge) might be combined to create a conceptual lens through which to teach synthesis as invention. My study proposes synthesis should be examined as a *cognitive process of invention* and framed in both hermeneutic and heuristic terms, placing the arc of novice-to-experienced *learning* at the center of discussion. Doing so opens the discussion up to the influence of interdisciplinary pathways concerned with

creative invention that occur at moments of construction, a central feature of invention whether it is being defined as a *heuristic* or *hermeneutic* practice.²²

While Kellogg and Whiteford help me frame this discussion in terms of novice/expert, such language has always been problematic for our field, both theoretically and pedagogically. To assign the term “expert” to assess student writing efforts may seem to imply a move from apprentice to experienced discourse community member within the span of a few semesters is even possible pedagogically. Further, to measure such a transition typically relies on assessment of writing products, not processes (as the process is often viewed in the service of the product), resulting in pedagogies of invention and synthesis that privilege the text assessed, rather than the student learner’s cognitive process. If we apply a cognitive lens (to both our theory and praxis), this discussion of what is essentially a skills-focused binary may shift toward a discussion of invention. Kellogg and Whiteford’s move to replace the labels of novice/expert with the process-highlighting terms of novice/mature recasts a discussion of learning to synthesize in writing as a process of cognitive development, characterized by an ability to mature from concept-telling toward concept-transforming (114-115). This is not an evolution that takes place within the span of one or two semesters of a freshman writing course simply by offering students reading-to-write examples or exercises. As Yancey et al. (108-109) and Applebee and Langer (21-26) observe, many of our freshman writers come to us from secondary school experiences that do not always equip them with the types of pre-existing knowledge that will directly translate into the expectations and demands of post-secondary writing. An example of this, as cited by Applebee

²² I recognize that Anabelle Lyon calls for a more defined separation between rhetoric and hermeneutics as it relates to invention, arguing that conflating the two produces an “interpretive frame” that minimizes rhetoric’s “productive” in favor of the hermeneutic in problematic ways (39). I point to this only to clarify that such a distinction is largely theoretical, while my proposed approach argues that invention may benefit at the functional, applied level in pedagogy by a more synergistic relationship when framed in terms of a cognitive/agency approach to synthesis processes.

and Langer, is the leap from writing instruction based in reading literary texts or test preparation in the high school curricula to the inquiry-based process of the first year college writing classroom (21, 26). Our field's current work in transfer theory suggests that our writing pedagogy—and specifically, I would argue, synthesis writing—is more successful when we explicitly engage students' metacognitive reflection practices (Yancey, Robertson, and Taczak; Wardle 2012; Ferucci and DeRosa). As Prior points out, our process pedagogy engages drafting as “tracing the composing of a text, what classical rhetoric termed invention,” but it also needs to engage students in explicit reflection on “tracing a structure of participation, of examining who is involved in making the text and in what ways” (169-170). As Ferucci and DeRosa explain, this need not be confined to alphabetic texts; employing cognitive offloading to a visual representation of that structure may provide our pedagogy with an essential step in creating new knowledge through synthesis writing.

Educational scholars define learning in terms of change (Ifenthaler and Hanewald; Hay et al.), and change (as Emig notes) is effected over time. This is where the “epigenetic” nature of writing as learning occurs, in the “complex evolutionary development of thought steadily and graphically [made] visible and available throughout as a record of the journey . . . to full discursive formation” (Emig 127). How such change is facilitated and assessed within composition classrooms, however, is often based on the textual artifacts associated with the conventions of genre, one of which is the research assignment. In these conversations, the *text produced* is frequently positioned as the object of the research—as an artifact that can be measured and assessed to signal “learning” has happened (e.g., Howard and Jamieson; Lundstrom et al.). In her work “Writing as a Mode of Learning,” Janet Emig argues that “writing uniquely corresponds to certain powerful learning strategies” (122) when viewed as a process

and as an “organic” (i.e., brain-based) based creative act (125). A complication to this assertion is that much of our field’s scholarly research on invention and synthesis writing largely relies on measurements that draw upon and are interpreted through a reading-writing lens: text-based discourse analysis, surveys, and information literacy habits, which focus more on the text as object than students’ creative agency processes (Spivey; Bazermann; Segev-Miller; Prior). While certainly reliable and easy to access as objects of study, this use of essay text raises another set of important questions about our pedagogy: how do we assess what students are doing in the *process* of building associational relationships between pre-existing knowledge and new sources of knowledge external to the student when synthesizing to develop a researched argument? How do we investigate the metacognitive “change” of learning (Hay et al. 297)? Certainly the current transfer “turn” in composition and its employment of reflective writing strategies may provide such an opportunity, but as long as the object studied is the finished text in service of an academic outcome, rather than the cognitive-creative invention process as the site of active learning, the factor of agency in learning still seems to favor the authority of instructional artifacts (the “what”) not the students’ knowledge transforming behaviors (the “how” and “why I did it”).

As previously mentioned, Prior points out that it is not enough to trace the text’s inventional process in terms of writing from reading; we must also trace the “structure of participation” (170). Mateos and Solé’s study of undergraduate writers suggests that students’ reading to writing capabilities were simply not enough to ensure successful synthesis efforts (448). Instead, what they saw was students applying synthesis heuristics mechanically, as any novice might, to a highly complex task that proves difficult for even advanced students (Segev-Miller studied upper division education majors’ writing, and noted a high degree of struggle).

Mateos and Solé concluded that students who relied on what Spivey asserts is the expected process of writing-from-reading (select, organize, and connect) lacked the element of “strategic thinking” (448).

To learn and practice such “strategic thinking,” of course, requires “strategic, informed teaching” that includes giving student writers opportunities to learn synthesis through both an epistemic (hermeneutic) as well as heuristic approach (Mateos and Solé 448). This means transforming our synthesis pedagogy and methodologies in ways that will allow us to locate, measure, and assess student writing in terms of *how and why* their agency and critical thinking-associational habits result in a rhetorical act of creation. Such a rhetorical adjustment also moves the focus from a value-based assessment of writing performance as framed by institutional standards (novice = C, expert = A) to students’ own knowledge creating (and transforming) processes. Kellogg and Whiteford’s proposed shift allows me to examine learning and invention in terms of cognitive development (“mature”), not merely skill acquisition (“expert”), tying together the intentional nature of composition as active construction of knowledge with an eye toward the students’ cognitive agency development from novice to developing cognizers. A commonplace in lesson planning, Anderson and Krathwhol’s Revised Bloom’s Taxonomy, drawing from recent cognitive research, points to this generative quality of creation of synthesis as the apex point of knowledge making. Bloom’s original term “synthesis” becomes “create,” defined as “[p]utting elements together to form a coherent or functional whole; reorganizing elements into a new pattern or structure through generating, planning, or producing” (Armstrong). In building this, the authors also created a parallel taxonomy which is not as widely applied in discussions of synthesis curricula, of knowledges explicitly connected to cognition:

factual, conceptual, procedural, and metacognitive (Forehand). It is the conceptual layer that I want to focus on next.

Our field's interest in transfer is an area where conceptualization plays a key role. The teaching-for-transfer trend is well established in our field's scholarship (as indicated by the 2018 CCCC conference sessions), and so I will not recount its history here. Instead, it seems sufficient to point to the theory's treatment of the cognitive in terms of conceptualization, a key term in discussions of synthesis practices when it comes to the sort of novice writers found in first year research-focused writing courses. As recounted in their 2014 work, *Writing Across Contexts*, Yancey et al. assert that discussions often struggle to agree on "how to conceptualize transfer" (7) and how students make use of "prior knowledge" (13-15). High road transfer calls for the more complex cognitive practices, but even this goal calls for students to be first situated as novices (18) for transfer to be taught effectively in order to make space for learning to "write into . . . expertise," citing work on the impact of freshman student identity formation by Sommers and Salz (19). This seems to imply a necessary "buy in" by student writers—a potential act of agency—for successful learning to take place, buy-in that might be facilitated using my study's constructivist-inspired interventional space of a DCMAP. When students are allowed to perform (in terms of building) a visualization of their conceptualization process within a DCMAP, they are provided with the opportunity to become—as noted by Bruillard and Baron—knowledge *designers* rather than knowledge reporters (335). Such an intentional designation foregrounds students as agents in this construction process, allowing for explicit instruction to focus on the act of representation as a means of encouraging reflection and recursive transfer. For example, source materials lead to reflection on their usefulness in terms of students' thesis ideas, which lead them to think of how and where that might suggest new

connections to other sources, and so on. Some mapping heuristics that are pre-structured as a knowledge fill-in-the-blank tool limit the ways students can structure emerging knowledge. However, if students are provided instead with a construction space that is unlimited and open like a DCMAP, this invites inventional opportunity for “buy in” by leaving the design choices of connection and representation up to students’ perceptions. In other words, their DCMAP space provides them with an opportunity to actively shape and design what *they* perceive is the structure of this knowledge-making: the conceptualization process that leads to synthesis. Battaglia’s work on the role of visualization in academic writing supports this view of visual/graphical elements’ value beyond just serving a connective function; he cites the benefits of “the spatial aspect of visualization” in creating a type of knowledge representation that serves a generative, inventional function (271). A DCMAP’s constructivist affordances, therefore, may offer a space in which to examine the role of such heuristics on developing this novice-to-experienced cognitive progress.

Here too, scholarship from MBE provides deeper theoretical support for this intervention in terms of teaching conceptualization as a process needed for synthesis writing. Models created by theorists in education science (and specifically in neuroeducation) are framed in terms of the central role of the student as *agent* in this learning in terms of “personal change”—a locus of *student* process (Hay et al. 296). Viewed from a constructivist lens, conceptualizing agency in this way allows for a more direct, active engagement with the epistemic, encouraging the type of “buy in” by students that might move them from passive to actively investing in the learning at the cognitive level. If we examine the phenomenon of learning as knowledge creation (which, by extension, includes synthesis) when framed in terms of text construction, this inevitably risks privileging the disciplinary expert role of teacher and the authority of text; in doing so, what are

we missing? I argue it is the opportunity to examine students' agency in the *process* of knowledge creation as a potential site for more intensive scaffolding to develop learning. In his work on tracing process, Paul Prior talks about intertextuality's role in this question of creative motivation. In his discussion of how we trace the production of a text, he cites Bazerman's definition of intertextuality as a dependent relationship of one text upon other texts (Bazerman 84); this relationship of texts then forms the basis of a writer's efforts to construct meaning and includes "[t]he student's own story of the process" (Prior 173). However, when we limit our discussions of student invention practices in synthesis to a discursive lens of intertextual analysis (familiar ground for our field's methodological tool kit), we may be looking only at student engagement with texts at an extrinsic level—where the knowledge created exists outside the student (i.e., source use)—thereby implying the authoritative weight of knowledge creation resides with the text. In doing so as part of our research and our pedagogy, we may also risk framing student invention (and synthesis) efforts as discursive product rather than cognitive process, interpreting synthesis as a lexical representation of knowledge gathered but not as an *action*—the process of students' critical engagement *in the act* of forming concepts. This very problem is addressed by Kellogg and Whiteford in terms of the "slow transition from knowledge telling to knowledge transforming" (118) as part of meaning making, where transformation requires concept building. Novice writers especially struggle with conceptualization as it is a complex cognitive process, which Segev-Miller and Spivey define in terms of creating "macropropositions" in the process of transforming concepts, not merely replicating the structure of the source texts (6-8). Segev-Miller observes that while this difficulty is cognitive, it is also linked to instructional efforts (8). While she points to the lack of research on discourse synthesis as a whole, she also observes that the dearth of research on the impact of explicit instruction of

synthesis on student efforts is also in play, thus affirming my study's premise to focus on intervention.

Promoting active engagement in our writing curriculum is key to “shift[ing] the authority toward the writer” (Medvedeva and Recuber 139), the type of rhetorical empowerment so valuable to an inquiry-based approach to writing and writing instruction (Bizzell and Herzberg; Brent; Bizup). Scholars like Segev-Miller suggest that synthesis would be more productively studied as a cognitive process because of the pedagogical potential of exploring student knowledge creation in terms of agency and the metacognitive. Framing conceptualizing as a cognitive invention calls for discovery of new or possible ways to make meaning by *creating* connections, connections which may be interpreted as *patterns* of relationships. When students struggle with this process, we often question why they fail to make such connections when the instruction relies only on a single strategy of reading-writing. Drawing upon MBE scholarship to frame meaning-making as a cognitive pattern-seeking behavior gives me the opportunity to explore how the intervention of my study might address this concern.

A Caveat

In this study, I am positioning myself and my research design within a community of not only rhetoric and composition scholars but also those from the field of Mind, Brain, and Education (MBE), whose self-described *raison d'être* is to “build on the best integration of research with practice, creating a strong infrastructure that joins scientists with educators to study effective learning and teaching in educational settings” (Fischer). Writing teachers benefit from a rich theoretical tradition, one that emerges from practice and research; the scholarship promoted by the interdisciplinarity of MBE can contribute to that. Neuroscience and brain-based learning

have become popular resources for enriching our classroom pedagogy, but it comes with calls for caution.

The tension related to privileging empirical research over the complex social environment of the composition classroom and its pedagogical history (Bruer; Goswami; Fahnestock) has led to skeptical and downright resistant voices from composition scholars like Fahnestock and Berlin, who caution classroom practitioners against an unquestioning embrace of an approach to learning based on some of the information processing models that emerged from the “cognitive revolution” (Fahnestock 159). For example, the information processing theory of “brain-as-computer” model is rooted in early 20th century computing science work but reemerged during discussions of the cognitive vs. humanist debate. This is perhaps most familiarly characterized by the tension in our field after Flower and Hayes first published their cognitive theory of writing. Objections to this model included its potential to negate student agency and social environment as contributing factors in knowledge and meaning making (the embodied and social factors of cognition), as well as pedagogy (Hutchins 707).

The MBE discipline also acknowledges there is a history of privileging authoritative knowledge directionally, from science down to teachers, in a way that often neglects to acknowledge that the flow from teachers to science is equally and vitally necessary. One of the founders of MBE, Kurt Fischer, calls out the limitations of such early models, saying theories and practices based on this model “talk as if learning occurs in the brain, leaving out the ways that body contributes to learning, as well as the roles that a person’s environment plays in shaping learning and providing information” (5). Instead, models based on this approach to cognition advanced an epistemology of information processing that treated learning as a simple binary of input and output, and the brain as a mere storage facility (5). Fisher also points to a

second model that contributes to influential teaching and learning myths, one which calls to mind Paolo Friere's Banking Model of pedagogy, with the teacher as the transmitter of knowledge "as if through a conduit, giving or pumping the information into the person. . . . Knowledge is available as information, and students are supposed to take it and use it" as opposed to constructing it (Fisher 5). Educational scholars like Judy Willis, David Sousa, and others promote the benefits of neuroscience-based empirical research in the classroom *if* based on sound educational theory and classroom-based research.

In the case of my study, the influence of MBE research into the cognitive processes of learning as knowledge transformation directly responds to these concerns through the intervention's design and methodologies. The DCMAP becomes a locus for and constructivist tool of student agency, with the student (not the teacher) as knowledge designer, thus modeling MBE's purpose as one shared by our own field: to "study effective learning and teaching in educational settings," a far cry from the computer- or lab-based approaches (Fischer 3).

Still, such concerns continue to be expressed and are certainly valid, as writing teachers—especially those who have not been fully trained in composition pedagogy and theory (such as contingent faculty or literature faculty)—may be unduly influenced by popular trends in brain-based learning resources. An example of such a problematic trend is what scholars in both neuroscience and education call "neuromyths" found in some pedagogy, teaching practices based on partial knowledge of scientific studies related to learning and the brain (Tokuhama-Espinosa; Bruer; Goswami; Fischer). Tokuhama-Espinosa defines such myths as "[c]oncepts from neuroeducation [that] have been applied indiscreetly and inconsistently to classroom teaching practices" like prescriptive learning styles (13). Flower et al., in *Reading-To-Write*, also point to the negative impacts of neuromyths in the classroom in the case of prescriptive connections

between stages of cognitive development deemed as “natural” sequencing of learning leading to “cognitive pigeonholing” into deficit labeling (65). Fischer takes a bolder stance, declaring that these teaching myths— “beliefs about how the brain and body work”—are “blatantly wrong” (4). Such muddied waters and the resulting criticism no doubt contribute to a history of tension between cognitive research scholars and our own field when faced with discussions of educational science that has been based on popular (but myth-based) publications promoting brain-based education rather than scholarly, qualitative studies within our field. Scholars in MBE like Fischer and Sousa address this directly, and in doing so touch on many of the concerns raised by compositionists critical of the “brain/information processing” approach to teaching and learning that emerged from the decades of interest in cognitive sciences fueled by advances in neuroscience.

While my research is inspired by the interdisciplinary work within the field of Mind, Brain, and Education, for whom learning and pedagogical applications are the common interest, it is balanced with foundational rhetorical and compositional concepts of learning and writing process instruction in order to mitigate the aforementioned concerns. In fact, grounding this study in roots of rhetorical invention tempers assumptions about locations of learning and theories informing interventional designs. For example, like other MBE scholars Willis and Fischer, educational researcher Tokahuma-Espinosa is careful to concede that “the neuroscience implications of brain and learning research for education are still largely suggestive rather than empirical” and brain imagery “cannot predict exactly what a strategy or intervention will mean for individual students” (Willis 46). From the cognitive psychologists and educational perspective, Brown, Roediger, and McDaniel assert that while “our understanding of brain mechanisms that underlie learning” is increasing thanks to such cross disciplinary work, “we’re

still a very long way from knowing what neuroscience will tell us about how to improve education” (8).

Taking such cautions into account, I argue that an understanding of the available research as it relates to classroom pedagogy can enhance and enrich the learning environment of the writing classroom, as well as teachers’ interventional designs. Fahnestock herself writes that scholars of rhetoric “themselves need not and should not imitate cognitive neuroscientists” but neither should they “be hostile to potential scientific grounding either” (175). For, as Willis observes, “[k]nowing the workings of the brain makes the strategies *we already know* more adaptable and applicable” (47; emphasis added). For example, active learning or activity based learning theories, including Ausubel’s 1968 theory of meaningful learning, inform our field’s scholarship’s interest in situated and embodied cognition (Hutchins; Haas; Murray; Syverson). When we combine these theorizing frameworks with explicit instruction on cognitively based learning and instructional strategies, we invite students to become actively engaged with their own identity as agents of constructing knowledge.

A Pedagogical Alliance: The Constructivist Bridge of Design Research

The On-Ramp of Transfer

My decision to theorize synthesis within a framework that combines rhetorical invention with neuroeducational and cognitive science may be problematic for some. However, recent work by Fischer, Sousa, Willis, Hardimann, Battro, and others in this emerging field of MBE have called for “a new approach to connecting research and education, with a two-way collaboration in which practitioners and researchers work together” (Fischer 3). The philosophy expressed by practitioners in MBE seeks a way to build a better “bridge” (Bruer), one that replaces the “traditional model” of science-informing- classroom as a one-way conduit that

“leaves out teachers and learners as vital contributors” instead of mere objects of study (Fischer 3). This interest in a new model coincides with composition scholars’ reinvigorated interest in metacognitive research (e.g., Yancey et al.’s work on teaching for transfer), a somewhat serendipitous parallel that points toward opportunities to recontextualize the epistemologies influencing our approach to pedagogy and learning/learners. This leads to one of the more interesting intersections where I find my research is informed by work in neuroeducation via a constructivist approach to learning, knowledge synthesis, and pedagogy, an intersection that draws from the Teaching For Transfer movement’s emphasis on metacognition (Yancey et al.; Winslow and Shaw). Aligning my work in this way with trending scholarship in our own field allows me to create a number of productive theoretical and pedagogical anchors for many of the connections I see as part of making a case for the DCMAP’s role in an inventional approach to synthesis pedagogy.

Active Learning & Design-Based Research

The confluence of this cross-disciplinary scholarship leads directly to my methodological design choices. Jonan Donaldson, an Instructional Design scholar in the field of Educational Technology, writes of a “learning experience design philosophy of building online and digitally-mediated courses in which technologies are used as Trojan Horses for emancipation through constructionist problem-based learning with an emphasis on learner agency, situating learners as designers, and focused tinkering” (“Travelling”). By viewing the synthesis learning process as inventional (creating, interpreting), my methods employ concepts of active learning (what Donaldson calls “[c]onstructionist learning”) based on the warrant that student learning is most effective when classroom pedagogy and instructional materials provide them with opportunities to “*make things of their own design*” (Donaldson; Bruillard and Baron; Boscolo et al.; Jonassen

and Reeves; emphasis added). This constructionist-based approach to conceptual learning allows me to design my study as a way to examine students' cognitive construction strategies by creating data gathering opportunities from student maps as artifacts of this design behavior. Accordingly, these maps, as presented through the interventional design, could potentially be seen as a representation of "mirror [of] the construction of meaning occurring in the minds of the learners" whereby the created "artifacts [might then] serve as tangible objects-to-think-with—tools of embodied cognition" (Donaldson). The affordances provided by the interventional DCMAP become the space where this can be explored. In the following chapter, I provide an overview of the methodological framework for my study's design and implementation emerging from this context.

CHAPTER III

METHODOLOGY

Context: Studying the Intervention in Place

This study is a mixed-methods, qualitative research study that uses an exploratory, rather than empirical, approach to answer my research questions. I selected this approach because it best suits my study's pragmatic approach to the "messiness" of a classroom environment, where student writers (when viewed as co-designers of the intervention) actively and reflectively map their progressive exploration of researched knowledge in a digital concept mapping platform. Such "messiness" of a "naturalistic setting" (Barab and Squire 9; Edelson 106) is the hallmark of a methodological approach known as Design-Based Research (DBR). Better known within educational/learning sciences as well as instructional design circles, DBR facilitates a number of data collection methods whose features best fit my research goals. Schleppegrell's comments on using DBR methodology as part of a real-world classroom intervention study succinctly illustrate my reasoning for my choice: "Context is crucial to design-based research, which does not focus on the development of a product, but instead on generating models of successful innovation that help us understand the nature of learning in a complex system" (157).

In this study, I intend to observe the complexity of the types of layered concepts associated with synthesis as cognitive invention at work. A mixed-methods approach to data gathering allows me to explore the interventional design process as well as the students' thinking and writing processes. Two research models were especially helpful in designing my study of these goals. Tokuhama-Espinosa's MBE-influenced research informed my varied approaches to data types—combining narrative with coding-friendly categories for analysis and boundary-crossing literature reviews—suggesting that the reproducibility of RAD research need not be

limited to an experimental design's outcomes. In addition, Segev-Miller's study design ("Cognitive") provides a model that demonstrates focusing on the interventional tool itself (like intervention design or rubric construction) may be productively reproducible.

Of course, the decision to examine a heuristic as my research focus comes with some concerns. One of the acknowledged difficulties of research interventions in a single classroom is potential for transfer to others' research and teaching. What works at one location may not be generalizable to another location due, in part, to the "messiness" of classroom environments (as opposed to more controlled testing environments). Haswell argues that the value of data produced by a RAD methodology is based on the premise that "data do not just lie there" (201). Such data must be interpreted in light of a complex web of environmental, practical, and theoretical matrices that surround and inform that data and the researcher's interpretation of same. To complicate matters, Creswell points out that the role of the observed has as much input on data formation as well as the analysis (192), which is a key characteristic of the constructivist leanings of current writing studies' qualitative research. Real-world classrooms are exceedingly varied, and so the question of transferability is a significant factor in choosing a suitable methodology for my study. Specifically, would my intervention design and its implementation be reproducible beyond the local classroom? A previous iteration of this study employed a grounded theory framework, and this point of reproducibility was an area of concern. In addition, the propensity of grounded theory approaches to data collection often relies heavily on interviews rather than observation (Creswell 148-49), yet my mixed methods approach draws more from observation given the object of study. These concerns would eventually contribute to my decision to shift to a different methodological framework: Design-Based Research. With its emphasis on research based on iterative stages of intervention, DBR allows me to address my

research questions based on the nature of learning and teaching synthesis in a first-year research writing course.

Here it seems appropriate to address a likely question: why a *digital* concept map? There are a number of reasons, explored later in this chapter, but the question of digital literacy is worth mentioning at this point. In her book, *How We Think: Digital Media and Contemporary Technogenesis*, N. Katherine Hayles observes that when close reading is predominantly taught as a textual practice, in text-based media, the *style* of reading common to digital spaces and platforms may be marginalized. The linear structure of text-dominant reading and writing practices, however, does not accurately capture the type of non-linear cognitive processes that students engage in when grappling with the higher-order thinking skills involved in synthesis. My plans to integrate additional ways to practice mapping in the classroom as a non-linear way to locate, create, and explore potential connections among materials may actually lessen the cognitive load. In addition, engaging with digital technologies and visual literacies—combined with these additional modifications—may also deepen opportunities in the lesson plans to help these students learn to “restructure” knowledge by making possible the sort of cognitively creative leaps across “epistemological chasms” when untethered from linear reading and writing practices (Petrie and Oshlag 583).

DBR: An Iterative Approach

DBR was not my first choice of methodology. Because early iterations of this intervention focused more on synthesis passages produced by student writers, a grounded theory approach (a common choice for rhetoric and composition research) facilitated discourse analysis as a primary data source for collection and analysis. However, as my study took shape, and on the advice of my committee, it became clear that grounded theory may not facilitate the real

focus of my research questions' focus on whether using DCMAPs beyond early brainstorming processes might facilitate teaching and learning synthesis as an ongoing inventional cognitive process. I also want to examine *how* student writers visually and reflectively represent their acts of creating structural knowledge via the DCMAP's affordances. In the current iteration of my study, the intervention itself (students' semester-long creation of DCMAPs) became the lens *through which* I examine synthesis as an inventional and cognitive process. Thus, I needed a methodological framework to study synthesis practices and pedagogies that would allow me to examine the intervention in terms of its design and implementation over an extended period of time (a single semester of 16 weeks). As a research methodology, DBR provides the needed flexibility in framing my study in this way because it allows for two different "orientations" to research: either the intervention *is* the focus of the study or the intervention "provide[s] the means for studying specific phenomena that are related to, but not the same as, the intervention itself" (McKenney and Reeves Chapter 1). This second orientation provides me with the means by which to study synthesis as a cognitive invention *process* from a pragmatic methodological approach (as opposed to simply theory-building or theory-proving) if I want to create conditions that might be relevant beyond my small-scale study. While a grounded theory framework tends to lead toward unified theory *building* as a primary outcome, a Design-Based Research (DBR) framework instead allows me to work toward developing "theoretical understanding that can be of use to others," but more so to "desig[n] and implemen[t] interventions to address problems in practice" (McKenney and Reeves Chapter 1).

Another factor in my choice has to do with the nature of the data to be collected and analyzed. Because my research questions inquire into student learning processes, I also needed data that might capture observable traces of students' thinking and writing processes in both

visual as well as reflective process writing as a means of assessing any benefits of using a visual constructive space to offload student conceptualizing processes. Grounded theory works best when data present more systematically (Cresswell); however, the classroom space as a site of research is notoriously messy—even organic—when it comes to potential data generation and correlation. Grounded theory also mandates a distance between researcher and subjects, a condition difficult to maintain when exploring new interventional designs in the classroom as an instructor. These concerns seem mitigated by choosing a DBR methodology incorporating conventions of a qualitative and mixed-methods research model.

The sections that follow provide an overview of my methodological evolution as driven by this shift in my approach. This DBR framework shapes my study’s design as I explore the following research questions about the epistemic and interventional nature of the mapping space and activity:

1. In what ways does the interventional, hermeneutical heuristic²³ of digital concept maps (DCMAPs) impact students’ constructive epistemic abilities? Specifically, if we can teach students to view synthesis as a cognitive process of structuring knowledge (Schema Theory²⁴), what benefits might be realized?
2. What role might DCMAPs as visual representation of student connections and knowledge conceptualization play in promoting active and progressive transformation of ideas?

²³ The symbiotic nature of these concepts as they pertain to writing is covered in more detail in the Literature Review.

²⁴ Schema Theory was explored in the Literature Review in terms of *structural knowledge*, but is essentially defined by cognitive scientists as the way our brains organize acquired knowledge in the form of units, creating meaning by relating patterns of associations (Jonassen et al. 16).

3. Can MBE scholarship and theories, when combined with an understanding of information visualization as a cognitive process, productively inform assignment design for synthesis and research writing in other first-year research writing classrooms?

The remainder of this chapter provides an overview of my study's framework and design, as well as briefly discusses the evolution of several iterations, including a shift in methodology from grounded theory to design-based research. I will also outline the methods used to gather data gleaned from my research study. From there, I will discuss the study's results and limitations.

Key Features of a Design-Based Research Methodology

Interdisciplinary in its origins, Design-Based Research (DBR) is a relatively recent phenomenon, and as such is still the subject of commentary and critique as both a research method and a field of study (Barab and Squire). Attributed first to Ann Brown and Allan Collins, DBR (which also appears in varied scholarship as design-research and development research) began in the field of design and migrated into the field of educational science (Christensen and West). This thread from educational science points to the influence of MBE upon my own research design and approach to synthesis as a cognitive process. Barab and Squire note that among learning scientists, there is a core “assumption” that “cognition is not a thing located within the individual thinker but is a process that is distributed across the knower, the environment in which knowing occurs, and the activity in which the learner participates” (1), a view of the learner very similar to our own field's emphasis on the social nature of the writing process. Such a complex landscape contributes to the emergence of DBR as a “methodological toolkit” that allows researchers to work in “naturalistic contexts”—i.e., real classrooms—in order to focus on developing and revising classroom practices in ways that can be translated to other contexts (Barab and Squire 2-5). The key characteristics of a Design-Based Research

methodology (sometimes referred to as Educational Design Research) are its (1) process focus, (2) iterative nature, and (3) a “theoretical orientation . . . that scientific understanding is used to frame not only the research, but also (alongside craft wisdom and creative inspiration) to shape the design of a solution to a real problem” (McKenney and Reeves).

Design-Based Research methodology does not have its roots in the composition field, and is a relatively new research model for composition pedagogy scholars. However, given the nature of our field’s emphasis on innovative praxis and cross-disciplinary resources, the methodology’s characteristics as explained by its founders and supporters offer a promising alignment of function and scope. Its origins lie predominantly in the field of education and education science. The Design-Based Research Collective describes DBR as “an emerging paradigm” (5), and indeed the field of writing studies has recently begun to frame research studies employing DBR. For example, in the 2018 *Points of Departure: Rethinking Student Source Use and Writing Studies*, Serviss and Rodrigue point to DBR as a useful tool for designing such RAD-oriented research projects that explore what the Design-Based Research Collective calls “learning in context through the systematic design and study of instructional strategies and tools” (Collective 5). There are a number of relevant characteristics of a DBR methodology that productively frame my study’s research questions about teaching approaches to synthesis as both a cognitive and a rhetorically inventional process.

One of the key characteristics of a DBR methodology is related to questions of interventional design. Because my study is predicated on the question of how students learn to synthesize their own pre-existing knowledge with researched materials, the design of the intervention must necessarily explore possible characteristics of successful learning *and* teaching strategies related to synthesis behaviors. This pragmatic nature of a DBR study demands that

results should be transferable beyond the individual study's environment. In the words of DBR's original proponent, Ann Brown, "an effective intervention should be able to migrate from our experimental classroom to average classrooms operated by and for average students and teachers, supported by realistic technological and personal support" (143). Therefore, this DCMAP intervention is framed as a means of examining these synthesis practices, without asserting a deterministic relationship. This allows for another key characteristic of DBR, which is to create "sharable theories that help communicate relevant implications to practitioners and other educational designers" (Collective 5). One of the acknowledged underlying premises of a DBR approach is "that existing practices are inadequate or can, at least, be improved upon, so that new practices are necessary" (Edelson 103). Given the continued call for improvements in students' synthesis practices, it is clear that a similar premise underlies my own study. For these reasons, a DBR methodology more effectively frames my questions regarding the intervention itself: how do the affordances of a DCMAP facilitate student learning, and what might this reveal about synthesis learning and synthesis pedagogy? Such a guiding question is supported best by the principles of a DBR methodology.

A Qualifying Statement: Researcher Identity in DBR

As previously noted, DBR is a highly flexible methodology, and available scholarship concedes that its defining characteristics are often represented in varied ways. Sandoval and Bell observe that one of the characteristics of DBR is its *lack* of a "singular definition" (201), but this degree of variability across disciplines may actually be seen as one of the methodology's strengths rather than as a deficit. As a number of scholars have explained, this flexibility allows researchers across disciplines to design studies that provide both "locally usable knowledge" while at the same time providing "sound, generalizable knowledge" in ways that both draw from

interdisciplinary knowledge while also addressing the needs of the authentic, local environments (Sandoval and Bell 199).

A number of publications have distilled these characteristics into a list of generalizations based on their frequency of reference (McKenney and Reeves; Collins; Brown; Barab and Squire; Serviss and Jamieson *Points* 97). Christensen and West compile this list into one that captures seven common features that “unite and define the approach . . . [as] design driven, situated [in authentic environments], iterative, collaborative, theory building, practical, and productive.” The collaborative characteristic has as its variable the makeup of the research team. Christensen and West observe that “the literature may not always agree on the roles and responsibilities of those engaged in DBR,” but Barab and Squire, as well as Collins, point to the multi-faceted nature of the researchers’ role in DBR methodology. Some scholarship defines the collaborative team as one that separates researcher from practitioner, and others separate researcher from designer. Anderson and Shattuck suggest that the reason for this separation is that teachers are often “too busy and often ill-trained to conduct rigorous research” (17), an observation that is directly at odds with our field’s experiences to the contrary. This separation has also been discussed as a means of avoiding researcher bias in the cases where researcher and practitioner/designer are one and the same. Barab and Squire point to this concern (10), but its mitigation has also been addressed as a feature common to most qualitative methods of research (Onwuegbuzie and Leech; Serviss and Jamieson “What Does Design-Based”). However, my study’s design is focused on my own classroom, making it more practical that my identity be researcher/practitioner/designer. In making this choice, I maintain the collaborative characteristic of DBR by framing students as the study’s co-designers and “co-participants” (Barab and Squire 3). In framing the study within DBR this way, I rely on scholarship of Barab and Squire, as well

as Collins, who are widely accepted as seminal scholars on the subject. Rather than creating an experimentalist relationship between researcher and subject (where the subject is merely to be observed), Barab and Squire, as well as Collins, describe the subjects of such a research study using terms like “co-participants” (Barab and Squire 3) and “co-investigators” (Collins 4).

Collins continues this line of reasoning to clarify that the flexible definition and constitution of the DBR research team allows for the collaborative characteristic to be fulfilled in other ways. Collins asserts that subjects are active collaborators, “helping to formulate the questions . . . [and] making refinements in the designs,” as well as “evaluating the effects” of the study (4-5). While some scholars may interpret this only in terms of practitioners/teachers, the design of my study actually frames students in this way. This is supported by recent work by Serviss and Jamieson, in *Points of Departure*, in which they discuss the role of DBR in writing studies. Specifically, they characterize the collaborative team as “most typically made up of faculty/administrators and students inquiring together” (97). The emphasis on collaboration as part of the methodology is designed to incorporate more than one perspective, which the student-as-practitioner role fulfills in my study’s design, and is an essential contributing factor to my focus on agency and learning in writing classrooms.

Prior Iterations: A Brief Review

As previously noted, an essential feature of DBR is its iterative design process. Before exploring the details of the current study’s design, it is helpful to first briefly review previous iterations. The first cycle of design occurred in 2014, as a short-term, informal instructional activity to help first year writing students map their early reasoning as an alternative to outlining connections to their ideas and sources. In this first iteration, I used an open access, iPad-based mind mapping platform called Popplet because of its simplicity and relatively accessible menu of

design commands. By the end of the semester, there was sufficient indication that this intervention was useful to students, and inspired the next iteration in 2016. However, for this next phase I chose a different concept mapping platform because of the developing instability and platform limitations²⁵ of the Popplet software. I examined a number of other mapping platforms, like Coggle and Mindmeister (two of the more popular sites described in concept mapping terms). However, a number of factors ultimately led me to choose Mindomo as the preferred platform going forward, including IRB-based protections for student privacy and options for closed classroom use (e.g., dedicated closed groups that offered the educator more control over settings for uniform data collection, as well as access point/sign-in requirements that did not raise FERPA concerns). For example, at the time, Coggle and Mindmeister sign-in/registration options required students share additional information like account information for their Google subscriptions (Coggle), a linking step that might burden students with information sharing concerns. Another contributing factor in my choice was the affordances of design tools freely available to students in these platforms. For theoretically-grounded reasons, I needed a software platform that would allow free design options (i.e., less hierarchical in appearance) as well as multiple options for multimodality (color, images, videos, text). Again, at the time, only Mindomo offered these in forms more closely aligned with concept-mapping theories of connectors and connector labeling (it should be noted here that both Coggle's and Mindmeister's platforms have since been modified to address these issues to some degree). Other features I considered important to my study's goals were only available in Mindomo, like the embedded notes and the history view features, as well as free download functions for archiving. Finally,

²⁵ Popplet was touted by the designers as a multiplatform software, for iPads and desktops. However, by the end of the term it became clear that the software was no longer being updated by the authors, and had become increasingly glitchy for student use due in no small part to its Flash-based software.

only Mindomo self-describes as a concept mapping platform, with templates that explicitly include a “blank concept map,” a needed distinction of function and form in terms of my study.

The second iteration was a micro-study submitted for IRB approval, and employed a mixed methods, grounded theory methodology. A control group was established, but it was drawn from one of four English 1020 first-year research writing courses I was teaching that spring. The duration of the study was only 4 weeks and took place in the final quarter of the 16-week semester. The three intervention classes used the Mindomo concept mapping program; the control group relied on a reading-to-write approach that examined student-written paragraphs that synthesize pairs of sources for any trends that might suggest potential correlation. The intervention students created individual Mindomo accounts, which added the type of potentially deleterious variable common to introducing new technologies to the learning environment (such as forgotten or unrecoverable passwords or account information). The focus of this second iteration was the synthesis writing produced, rather than the design of the intervention itself. Because Grounded Theory was used, results were largely quantitative. The purpose of this iteration was more theory building, following grounded theory, examining student writing in an effort to “build [an] explanatory framework” (Charmaz 510). Findings—especially those resulting from applying a synthesis continuum to student writing samples—seemed to suggest a sufficiently beneficial correlation between mapping and writing to inspire a new round of IRB-approved research²⁶ in the third and current iteration.

Changes made to this third iteration are discussed elsewhere in this chapter but may be summarized in terms of focus and methodology. In the spring of 2018, I fine-tuned the focus of

²⁶ This study was approved as a modification of an existing IRB-Exempt research project IRB#2018-04 by the host institution where the research actually took place (Auburn University at Montgomery). It was originally approved as Exempt by Old Dominion University’s Institutional Review Board on 10 March 2016. See Appendix E for details.

the previous iteration, and expanded the study's duration from 4 weeks to 16 weeks of map designing. My focus moved from the students' synthesis writing artifacts to the intervention itself: the DCMAP. This led to a change in my chosen methodology, moving from grounded theory to Design-Based Research because of its flexibility and its allowances for students in co-creator roles and in an authentic "messiness" of context. This also allowed for more qualitative-based findings, relying more on rich description to capture "what was going on," something quantitative analysis alone cannot always do. I also modified the theoretical lens to focus on rhetorical invention rather than information synthesis as "conversation." Measurement tools were also modified, to extend from simple discourse analysis to incorporate data from visual design elements as guided by dual coding theory, concept mapping research, and cognitive neuroeducation theories of learning.

Overview: Key Assumptions From a Dual Theoretical Lens

This study examines the impact of an intervention and its design on student synthesis thinking and writing processes. My methodology situates this intervention within a theoretical framework that explicitly defines synthesis as a *cognitive* process of rhetorical *invention*, for both instructor and student writers. Of all the concepts related to rhetorical invention, interpretation and creation are integral to my study's design choices as they allow me to conceptualize synthesis as both a perceptual/cognitive as well as constructive act of knowledge transforming (Lauer *Perspectives* 10; Lauer *Invention*; Segev-Miller "Discourse Synthesis" 5-6). An additional core concept that guided my study's design is the definition of knowledge as structural in nature, as discussed by Jonassen et al., specifically as it informs discussion of the epistemological nature of concept mapping.

In order to examine the synthesis process in my classroom in response to my study's Research Questions, I selected two primary theoretical lenses to frame my methods. My first framing lens is Rhetorical Invention theory (as advanced by the works of Lauer and Atwill, as well as Young and Liu), because it allows me to examine the impact of extended classroom use of a Mindomo DCMAP as both a creative and interpretive site for student-driven visualization and construction of their progressive cognitive processes. Drawing upon the concept of invention-*techné* allows me to discuss students' process work within the DCMAP space as literal acts of knowledge and concept construction (both key features of synthesis writing). The DCMAP represents a physical act of path making, as students explicitly perform acts of knowledge construction, with the potential to "enable new perspectives, new points of contact—even new destinations" (Atwill *Perspectives* xx). Such path making, as both a cognitive and invention act, is highly relevant as a concept that bridges my two primary theory frameworks and is key to my study's design.

Woven together with this first theory is the cognitive—as actualized using a constructivist or Active Learning approach to lesson design. This creates the theoretical framework I have used to tie together the complex influences at work in my study's design evolution. As discussed in the literature review, there is limited research from our field that theorizes synthesis writing or methods of teaching synthesis in the first-year writing classroom. This led me to frame my study by weaving together both cognitive and rhetorical invention theories in order to explore synthesis thinking and writing as *actualized* cognitive invention by using a visual heuristic (the DCMAP) to both represent and elicit reflective knowledge construction strategies.

My choice of methodological lenses is further determined by a significant challenge in designing this study: the acknowledged reality that learning “to do” synthesis is a highly complex and difficult cognitive process. Teaching that process is no less challenging. Add to that is the need to establish a larger theoretical understanding of the “how” of synthesis in order to facilitate improving instructional pedagogy designs that can be adapted for use beyond this small-scale application. Here I found that theories of cognitive processing in concepts of active learning and rhetorical invention were particularly valuable to my study’s design. Drawing upon cognitive process theories of writing and learning as they have evolved thanks to multidisciplinary studies of learning, I used their insight into conceptualizing knowledge construction to inform the design of the intervention. For example, influential neuroeducational theories of learning and their scholarly emphasis on ways to improve the “conceptual thinking skills” of our students through pedagogy (Willis 62) provide me with an epistemological view of knowledge in terms of cognitive processes. This in turn serves as a framework in which to examine how students make use of a DCMAP’s affordances as they construct visual traces of their conceptualization efforts in what Hay et al. refer to as “mak[ing] learning [and associated processes] visible” in ways that allow for examination and measurement (295, 304).

In terms of synthesis pedagogy, applying cognitive processing theory allows me to explore the DCMAP as *more* than a static technology tool. Instead, it becomes a *constructivist representational space* where students, as active designers and co-developers of the interventional heuristic, create images of their own processing and conceptualizing behaviors as a way toward making meaning. Situating the intervention’s design in this way allows me to treat student mapping as an act of agency as they position themselves as *designers* of knowledge within their own map spaces. As they actively and intentionally trace out manifestations of their

emerging knowledge processing and concept building (mental models) in the DCMAP over an extended period of time, the dual lenses of rhetorical invention and cognitive process theories create an opportunity to apply a key feature of DBR: the “development of solutions to problems of practice” while also developing “theoretical understanding” in ways that can be applied beyond a single environment (McKenney and Reeves Chapter 1). In doing so, inventional theory and cognitive theory allow me to observe what emerges when I operationalize two sides of the pedagogical coin: the constructivist-based design practices of an intervention and the active agency of students mapping their knowledge-construction practices.

The DCMAP thus becomes a vehicle for a type of reflective practice that may have the potential to make visible what in current methods of synthesis pedagogy and practices may remain implicit or unacknowledged (by both student writers and instructors) in the cognitive-based act of knowledge transformation. By using a rhetorical invention lens that manifests a constructivist, cognitive process approach to writing, I am able to frame my study of synthesis behaviors in terms of knowledge- and concept-building strategies, rather than informational literacy skills. This focus correlates to the interventional potential of the mapping affordances as structural as well as epistemic in nature, creating a potential for data coding categories that acknowledge both theoretical influences.

Further, because my study’s design process is predicated on re-framing synthesis as a cognitive and rhetorical invention process (synthesis-as-cognitive-process), a DBR methodology allows me to take a more pragmatic approach to shape the design and data gathering methods, as well as to frame my research question about the efficacy of our field’s pedagogical tools and methods we currently employ to teach synthesis thinking and writing in a freshman research writing classroom. This study examines student learning, but not to simply measure and assess

student synthesis as a writing *product outcome*. Because the neuro and cognitive science underpinnings of learning sciences scholarship is acknowledged all around as emergent (see “Minding the Brain” by George Hruby), there is little consensus in scholarly vetted research about correlations between cognition and behaviors within educational as well as neuroscience fields—and is a focus that is largely absent from rhetoric and composition studies. Therefore, the methodological focus of this research is less about causation-to-theory and more exploratory and interpretive, design-to-intervention-to-theory. Choosing DBR as my methodology for this exploratory study allows me to examine a classroom pedagogical intervention that integrates a digital concept map (DCMAP) as a created, long-term visual representation of student cognitive processes involved in synthesis behaviors. In short, because my methodological choice allows me to focus on students’ conceptualizing processes *through* the intervention’s design and the design affordances available to student designers, my data gathering strategies encompass the affordances of the intervention as well as the students’ process choices.

Observing Synthesis: Pedagogy & Study Design

Standards used to assess students’ synthesis efforts (as a textual artifact) often focus heavily on text-based discourse analysis methods (Segev-Miller; Lundstrom et al.; Oakleaf; van Ockenburg et al.). I want to apply a new focus in this study: on the cognitive and inventional processes of synthesis-as-cognition. To do so, I needed a methodological framework that accommodates triangulating a wide variety of qualitative data related to this process, including interviews and surveys (Bizup; Segev-Miller), think-aloud protocols (Emig; Flower and Hayes; Segev-Miller), textual analysis of both student and teacherly artifacts (Oakleaf; Head and Eisenberg; DePew), visual content analysis (Huckin), and case studies (Hay et al.). Moreover, because my research question and study design are shaped by theories of learning and

epistemology from a variety of fields (writing and composition studies, cognitive science, neuroeducation, and design studies), I needed an approach that would allow for such multidisciplinary influences upon data and analysis. Additionally, I needed to account for student designerly processes *from the student agency perspective*. While talk-aloud protocols (TAP) are a commonplace in our field's research of students' process thinking, the user of a DCMAP creates another layer for exploration and study: the physical act of mapping as students' meta-reflective representation of their knowledge discoveries and connections.

The Design Framework: Setting the Stage for Data Collection

The choice of a concept map was, in part, driven by the need to provide students with a metacognitive bridge between a familiar concept (the progressive wayfinding journey of constructing a map) and the less familiar writing and conceptual practices of analytic synthesis tasks so essential to college-level work. As an instructional intervention practice, a mapping heuristic is not new. The added affordances of a *concept* map extends this early work with interesting potential for my study's design. As laid out in the literature review, research literature of both neuroscience and education/learning sciences promotes the concept of mental models as an extended cognitive process heuristic, allowing me to employ the metaphor of maps at the beginning of the study to illustrate to students the complex nature of cognition in an effort to help them visualize what takes place prior to and informing their written work. This metaphor also has powerful implications for my research design in the way it allows me to frame learning outcomes for my students, especially in the case of such a difficult concept as synthesis. The concept of mapping I am using draws deeply upon Lakoff and Johnson's observation that our students engage *daily* in metaphors to aid cognition and practice as part of the workings of their "conceptual system" (3). This core operational experience allowed me to introduce concept

mapping to students as a way to actualize this familiar metaphor of mapping to represent thinking and concept building processes as emerging pathways and connections. Thus, the metaphor of a spatial and orientational map framed the assignment parameters of student-generated mapping of their own knowledge construction and cognitive processes, giving knowledge and synthesis “a new meaning” (Lakoff and Johnson 142). Students’ metaphoric creation (i.e., synthesis of knowledge to create new concepts) using the DCMAP thereby creates a concrete space and view of this process that allows for data collection that includes both reflection (journals and narrated visual progress reports) and construction (mapping as a prelude to writing synthesis passages for drafting). As such, the concept map’s role as an orientational metaphor becomes a lens through which students’ pre-existing knowledge and reasoning *becomes* the structural framework (or system) of their emerging pathways for building and representing knowledge.

A mixed methods approach facilitates the use of a number of data gathering tools, for which the DCMAP provides a number of outcomes and practices for observation. In addition to the structural choices serving both reflective and constructive opportunities for data gathering, an additional outcome to be measured is that of the transformational potential of the DCMAP as a visualization of emerging patterns. The implied relationships that necessarily emerge from the creative act of building a “system of concepts” are crucial to the task of helping students perceive their own agency within a wider conversation of source ideas they are creating through research synthesis. This means data must also capture pre-existing knowledge and beliefs that shape these perceptions. The conversational metaphor I use in the classroom accounts for some of the cognitive awareness required for synthesis, but by itself may leave students with an impression of accumulating rather than integrating, repeating or regurgitating rather than *creating*

personalized “new conceptual structures” (Segev-Miller “Writing From Sources” 6). To counter this, my study’s design draws from concepts of design as theorized by some neuroeducational and cognitive studies, specifically in terms of the affordances of a visualization space. This is where I looked for any evidence of students using the DCMAP features to make visible their ongoing learning choices as they reflect and connect their ongoing processes of inquiry. Rather than relying on a traditional discourse analysis of students’ essay-based synthesis paragraphs, the DCMAP graphical affordances provided multimodally-grounded data framed in terms of the meaning making process.

This points to another data collection point based on my research question about the potential impact of DCMAP visual elements on students’ ability to cognitively process and transform any graphically constructed connections from the visual space to their conceptualizing of abstractions. This allows me to look for any effects of the intervention in terms that Hay et al. argue most instructors know from first-hand experience: that students often struggle with the process of abstraction, especially when asked to form the types of complex systems of concepts consistent with synthesis as meaningful learning (Spivey; Segev-Miller; Bizup; Jamieson; McGinley; Sommers and Salz). Therefore, my methodology includes interactive space for scaffolded process activities, incorporating mapping moves in unison with ongoing student inquiry work to create visible spaces for evidence of meaningful learning as an ongoing, inquiry-based construction. These included pre- and post- questionnaires to gather data on student agency beliefs related to research as well as mapping as a conceptual tool. Data was also gathered from process drafts, reflective journaling guided by directed prompts, as well as final research essays submitted at the end of the study. My reasoning behind this component of my methodology draws from a key definition of learning employed in theories of concept mapping;

Ausubel's criteria for meaningful learning emphasizes the essential role of students' prior knowledge in this constructive process, as well as their intentional role as agents in that construction (Novak and Cañas 3).

As my study continued to evolve through its third iteration, I increasingly focused on the process of synthesis-as-cognitive invention, rather than a discourse-analysis of finalized synthesized artifacts. Thus, I required a methodology that would allow me to explore the actual inventional process from a cognitive perspective. As mentioned, the role of the student learner/writer (agency) is an important component of my study. Choices made by students as part of their design process/processing as they create their individual DCMAPs are examined as representations of their personal cognitive process, thereby making them co-creators in this research study.

Methods

Study Design Planning: Spring 2018

In the Spring of 2018, I implemented an IRB-based intervention in the second semester research writing course of our university's core writing sequence (English 1020), employing DCMAPs. This intervention was a core instructional and learning tool for a semester-long process activity in support of students' research and synthesis writing practices. This was the third iteration of this study and modeled after Rachel Segev-Miller's cognitive approach to a study on discourse synthesis as a theoretical and practical model for data gathering and analysis. While Segev-Miller's work focuses on upper division writing students, her exigence for examining the synthesis strategies of student writers mirrors my own: the lack of research in the field of composition on synthesis practices as a cognitive process. My preliminary design stage was further guided by Lundstrom et al.'s 2015 published work, "Teaching and Learning

Information Synthesis.” Their step-by-step description of a rubric creation process to assess information synthesis in student writing is preceded by a critical observation regarding our field’s operational definition of synthesis: there is nothing in the literature that offers a universally agreed upon version. This is a discovery reminiscent of Tokuhama-Espinosa’s emphasis on the role of standards and a perceived need to “replace current study programs . . . [and] change teaching methods” related to information literacy (xxiv). My study’s purpose, however, is more locally pragmatic: examining synthesis pedagogy and student inventional processes.

Participants & Intervention Use

In order to create a comparative frame of reference for my study, student participants were divided into two groups: Intervention and Control. The Intervention group used digital concept mapping as an integral part of their process work and research; this group was comprised of two sections of my English 1020 courses (approximately 40 students). While previous iterations of this study situated Control group students within my own classroom sections but without the DCMAP element, for this iteration the Control group consisted of students drawn from three sections of English 1020 taught by other instructors who agreed to be part of this study. This was an effort to add additional observational distance to avoid data bias. Because my study is focused on the actual intervention (the DCMAP and its use), not the student writing alone, the sampling of student writing drawn from other instructors’ English 1020 sections was examined to create needed contrast and to create a more diverse population for sampling.

In keeping with the practices of qualitative, mixed methods research on a small scale, this study’s design incorporates both purposeful sampling to identify and compare data, as well

as applying criterion-based methods of sampling to facilitate later data coding for memoing and analysis (Cresswell 158). One such criterion of importance is the use of the various multimodal components of the intervention (i.e., the affordances and features of the Mindomo platform). The DCMAP space itself, as previously mentioned, is an important source of visual data, a consideration that directly informs the data collection methods and the types of data produced. For example, my research questions are focused on the epistemological practices that reflect the roles played by student agency as well as cognitive processing in the constructive practices of synthesis, or the how and why of the visualization artifacts created through DCMAPPING. In other words, I wanted to explore the map space as a representation of both artifact and cognition. Here again, because my study's theoretical lenses incorporate both cognitive and rhetorical invention theories, the theoretical underpinnings of a DBR methodology affords me with significant and compelling ways to examine the visual elements of the DCMAP for data collection and analysis.

Assignment Arc as Process

The basic set of assignments are the same for all ENGL 1020 courses in our program in order to provide a consistent arc of instruction. The Control group classes use similar assignments and scaffolding based on a process approach to writing an end-of-semester researched argument essay. The key difference is that the Control group does not use concept mapping, relying instead on teaching materials that emphasize a non-visualization approach to synthesis writing (reading/writing text). In contrast, the two Intervention groups actively participated in visualization of their research process using digital concept maps (DCMAPs) created using an education subscription to a Mindomo account that I manage. I opted for this in-common account in order to minimize the types of variances and user issues with the

program compared to previous semesters when students created individual accounts. In the subscription space, each student is provided with a preassigned username and login password to a shared assignment. A clone of an instructor-built basic concept map template is made available to each student. Again, this choice was made to potentially limit starting variables, assuming students are unfamiliar with the software and concept mapping as a heuristic. To further limit the impact of environment as an external variance, Intervention Groups attended class in the same technology-equipped classroom.

Activities and assignment texts were designed to operationalize the cognitive, intentional nature of the synthesis process. Observing the concept mapping processes of students through Mindomo's archival features allows me to examine "the work, and the movement, and the flow" as potentially metacognitive moments of intent (Latour 143). This feature of my study's design reflects the map as a space where I might look for students' metacognitive and process experiences as they visually represent and translate the particulars of source materials located as part of their research, what Marilyn Cooper describes as "rendering virtualities as actual" (188).

The map intervention as part of the ongoing research assignment also provides a means of graphically and conceptually locating the abstractions of students' cognitive processes and connections (Cooper's "virtualities") when visualized using the connective affordances of the concept map's features to locate where the associations are happening. As previously mentioned, my study is predicated on the assumption that student synthesis is more than just a textual product or goal, and such "traceable associations" made visible via concept mapping as a data point may help me underscore that point. Student map design affordances like connector lines, category-creating color use, proximity and alignment of features all potentially represent these traces as data resources to be analyzed in terms of students' construction of what Boscolo et al.

call “an *intertext*,” created when a “writer has to elaborate different sources of information, and to compare, *transform*, and integrate them in a more inclusive one” (422; emphasis added). Since I am using the DCMAP intervention as a through-lens to examine synthesis, this act of “[t]ransformation . . . [as] an active and constructive process” becomes a possible analytical focus to explore how student writers apply “new ways” to represent source materials and connections in the form of “the reader’s mental representation of its meaning” (Boscolo et al. 422). Such “connections” may be interpreted as potential sites of emerging “traceable associations” made visible by the affordances of the digital concept map’s construction features, allowing me to locate these processes of synthesis on a visual plain for data analysis.

In the analysis section that follows, these data will be triangulated with other sites of data collection: pre- and post-survey tools, student-generated recordings of their reasons for *creating* each stage of their maps using TAP strategies, textual analysis of synthesis writing passages from their research project draft stages, and post-semester volunteer interviews.

Instruments & Data Collection: Triangulation

The visualization elements of the DCMAP are partnered with student reflective writing in the form of regular journal assignments, and agency-related data emerged from questionnaires as well as other journal tasks designed to promote synthesis behaviors in the form of draft paragraphs. Table 1 illustrates the range of data forms:

| Instrument Type | Data Type 1 | Data Type 2 |
|---------------------|---|--|
| Questionnaires | Pre: agency/researcher identity, pre-existing knowledge of research strategies | Post: reflection on impact of visualization and synthesis thinking and practices |
| Reflective Journals | Reflective map processing | Reflective writing/research processing |
| Map Design Progress | Student narration of design choices as related to function and relationships/pattern building | Observation & analysis of design choices as meaning making tools, representation |
| Drafts | Progress drafts of synthesis paragraphs, textual analysis for evidence of transfer | Final essay for textual analysis for evidence of transfer |
| Interviews | Informal conference discussions on early learning benefits & methods of use | Formal post-study on “learning” benefits ²⁷ |

Table 1: Instrument Types Used and Data Forms Collected for Analysis

Implementation: Spring 2018

The study takes place over the course of a 15-week semester, with classes meeting two days a week for 75 minutes at a time. During this time, all groups progress through a common curricular arc of four assignments, which are outlined in greater detail in my article in *The Journal of Teaching Writing*, “A Proposed Redesign of the Research Arc of Freshman Composition: Renegotiating and Remapping An Approach to Information Literacy.” The arc consists of a scaffolded progression of related assignments: (1) Informal Topic Inquiry & Proposal, (2) a Critical Source Evaluation & Annotated Bibliography, (3) Informal Outline of Argument, and (4) Final Sourced Persuasive Argument essay. Concept map work begins with the first assignment in the Intervention group.²⁸

²⁷ Only one student volunteered for an interview, making this category less influential.

²⁸ While this first phase was originally scheduled to begin during weeks three and four of the semester, unanticipated snow storms in Alabama forced us to push back to week six our deeper reflective engagement in the DCMAP space. This is discussed more extensively in the Limitations section.

As student agency is a key area of focus in my study, any data collection must account for pre-existing knowledge. For my purposes, such knowledge includes not only students' experience with their chosen topics, but also experience with technology interfaces and their self-awareness as researchers. To capture data on their research experience, both Intervention and Control groups completed an anonymous, Likert scale questionnaire before the study began that focused on their perceptions of research writing and their roles as researchers to provide a baseline representation of their agency and research experiences/practices, as well as provide an additional data collection node. (See Appendix B.)

Pre-existing knowledge also extends to the types of technologies required by/used in the classroom. I knew that when asking students to work with new technologies, I had to account for the influence of the "screen." Students' pre-existing knowledge with concept mapping and the DCMAP software platform (Mindomo) could not be assumed, so to circumvent potential accessibility concerns (Selfe and Selfe; DePew), I devoted regular class time to helping students navigate the Mindomo platform and its affordances in a hands-on environment before and after beginning their individual work in the DCMAP space. During class time over several days at the beginning of the semester, students in the Intervention groups were actively guided through the basics of accessing the prebuilt Mindomo assignment and map template before beginning their individual work in the digital concept map space. I first modeled the process for the students while they practiced in kind in their own space, which allowed me to help students navigate the space and its affordances in a hands-on environment to circumvent any concerns of accessibility (Hawisher and Selfe; Selfe and Selfe; DePew). As part of this orientation period, I provided a basic vocabulary sheet of key terms (see Appendix D) and "sandbox" time for modeling and practice during class using desktop computers in the Composition Media Lab

classroom. These terms would later inform the early data coding process by providing emerging categories.

By week four of the course, as part of in-class workshop activities, students in the Intervention group began constructing their maps by placing their own ideas on their early topic choices as stand-alone concept nodes (previously described in an earlier chapter). During a subsequent class, students in the Intervention groups then progressively added separate nodes for one or more Research Question(s) developed during group in-class activities. Additional nodes follow during subsequent class days, including: a Tentative Working Thesis (characterized as an “I Believe” statement), anticipated supporting points (characterized as “Because” statements, thought of as extensions of their “I Believe” claim), and early instruction on how to add descriptive Labels to each connector line to capture the conceptual nature of the relationship they envision connect these nodes. As part of the lesson’s scaffolding at this point, labeling terms such as “claim” and “premise/reason” are provided to students through instructional materials such as reading assignments and in-class discussion for use in their maps at this stage. These labels would also provide additional data nodes for comparison and tracking usage across assignment materials, DCMAP content, journal entries, and writing artifacts (see Appendix D for copy of “My Map Instructions” sheet).

Additional data were gathered from progressive stages of student mapping captured in both visual snapshots of design choices and reflective talk-aloud recordings of their design processes over an image of varied stages of map production. These earliest DCMAP representations consist only of nodes and simple linear connectors that represent students’ pre-existing knowledge—thinking about their own thinking—with no representation at all of source materials. This parallels the overall course design, which places greater emphasis on student

exploration of their own knowledge and processes (Unit 1: Topic Proposal) before moving on to conducting research in Unit 2. During the same period, the Control Group students work through text-only based invention strategies for their early proposals. (See attached assignment samples provided in Appendix D.) In parallel to their work in the map space, students actively composed weekly journal entries on their experience. These reflection journals were designed to promote responses that would make their thinking visible by using instructor-designed prompt language to solicit the “why” of their thinking, especially in conjunction with the what and where of their mapping behaviors.

In phase two of the assignment arc, the Intervention group is guided through populating their early maps with new nodes that represent sources discovered through preliminary research efforts that employ key terms identified through early thesis question generation activities. These terms are then progressively represented in the evolving maps through the creation of new nodes containing the text of the source citation. For each new node created, students are asked to create a connected node that adds their choice of a quotation from that source they feel best captures the source’s argument, its claim type(s), adding a Connector Label that includes a word or short phrase that indicates the purpose it serves for the student researcher. These progressive construction choices are presented with the emphasis on the student as agent of knowledge construction. They also created a recursive reflection opportunity as they journaled about ways their design choices may reflect associational thinking. Many journal prompts asked them to regularly reflect on and articulate their reasoning behind their designer decisions (colors, shapes, arrow directions, relationship labels, layout) as reflections of their thoughts on how these illustrate their active role in constructing new knowledge by designing new relationships in their map spaces. These evolving design choices made as part of creating the journey of their research

thinking would become an additional area for data collection and coding. Figure 3 is a screen shot of the example shown to students during one of the earliest workshops.

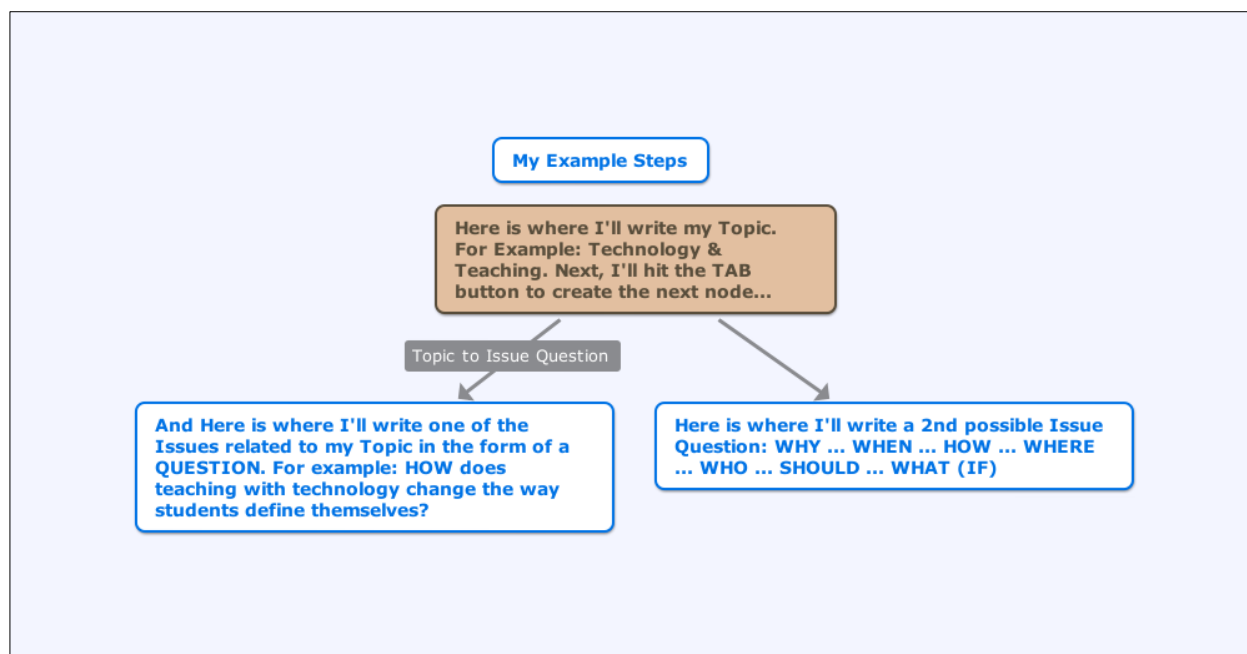


Figure 3: DCMAP Instruction Example, Unit 2

From weeks six through twelve, this process continues as an on-going and progressive weekly activity during which students are asked to create new map elements (nodes) as they discover new conversation partners (source materials) through in-class research workshops. In contrast to the Intervention group, the Control group classes progress through the same process of exploring source materials, but without the visual element of the mapping. Intervention groups are then guided through in-class activities to begin drawing connector lines between these source-based nodes (including student commentary on essential concepts provided by these sources) and nodes created to represent student ideas/argument points. During this same class time, students are asked to practice using other digital affordances of Mindomo to

promote student conceptual agency: actively locating and visualizing relationships using the platform’s connector labeling features, color-coding options for categorizing nodes, and arrow graphic elements to signal directional/causal/patterning relationships. Figure 4 below illustrates an example I provided to students as part of an in-class instructional and modeling session on creating and designing conceptual labels to signify the rhetorical nature of their connections.

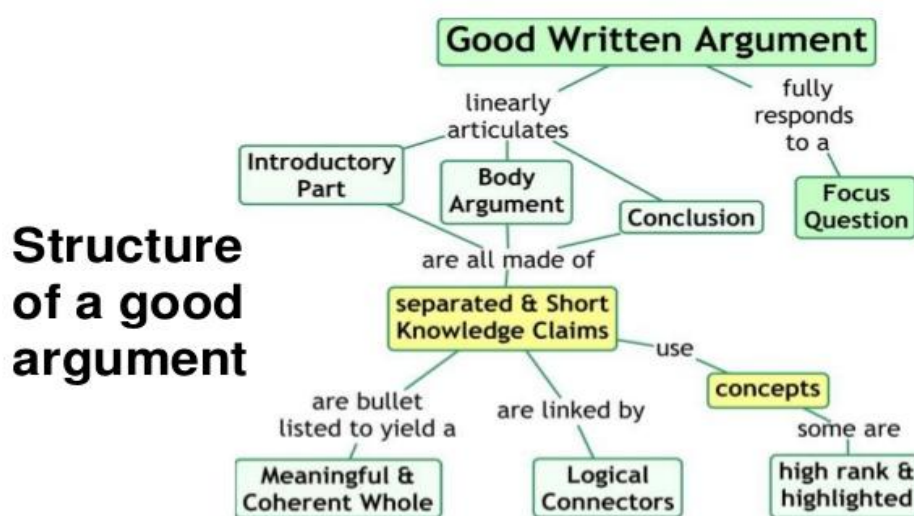


Figure 4: DCMAP Instruction Example, Conceptual Label Use²⁹

During in-class workshop, students are shown how to add more conceptually-oriented lexical labels to each connector to elaborate on the nature of these relationships, using the lexical vocabulary drawn from a list of key terms commonly associated with active relationship-making and Bloom’s Taxonomic synthesis-action language drawn from their course materials. This handout also includes a selection of key terms drawn from cognitive scholarship related to ways

²⁹ This image shown to students was an instructional example borrowed from Alfredo Tifi’s SlideShare related to his paper, “Concept Mapping and the Development of Argumentation in the ZPD,” Sixth International Conference On Concept Mapping, 2014, Brazil. <https://www.slideshare.net/tifialf/shareable-santos-presentation>.

the brain uses categorization and pattern recognition in learning (Tokuhamas-Espinosa). (See Appendix D.) In contrast, at this stage Control Groups only work with pre-existing text media as they create an Annotated Bibliography of sources. All along, the Intervention group's mapping process parallels their progressive, recursive writing process steps involved in creating writing projects, including reflection journals, reading responses, short paragraphs, and drafting stages (both rough and final) of all unit projects submitted for assessment. Students are regularly reminded to work from their maps to their writing, recursively, moving between these two modes of creation in a process of reflective building.

Additional data is provided by students' incremental process and draft writing samples (the Intervention group publishes these in a research journal using Blackboard). Both Control and Intervention groups have been instructed to regularly compose process drafts related to their research. By mid-semester, the majority of these small writing samples are focused on the sources they have found as part of their ongoing research efforts. The Intervention Groups' directed synthesis writing activities begin in an in-class workshop demonstrating how to build visual connections using their Mindomo DCMAP, as described above. Drawing upon the original course metaphor of map making, guided activities incorporate the language of paths, relationships, and conceptual function to facilitate any potential for transfer between the mapping experience to the synthesis writing practices in their drafts. Students are asked to reflect on this process in journal entries along the way, creating another data set. In contrast, the Control group uses only the synthesis guidelines and examples drawn from their course materials and texts, following a readerly-synthesis approach that stresses comparison and summary to write their synthesis posts. For data collection and comparison purposes, Control group writing samples are randomly selected and collected by their instructors from three or

four students, scrubbed of student identifiers, and provided to the Principle Investigator at designated regular intervals: (1) early semester synthesis attempt, (2) mid-semester synthesis sample, and (3) final researched argument essay.

The Intervention and Control Groups' writing samples (small paragraph samples from journals as well as a sampling of final research papers gleaned from both groups) are examined as part of sampling data. In an earlier iteration of this study design, a modification of a rubric designed by Lundstrom et al. for their 2015 study of synthesis was used for coding the writing samples. This rubric was designed to detect what Lundstrom et al. describe as observable "markers," which in the case of this project includes terms associated with synthesis as a critical thinking practice. In this iteration, however, the particular rubric was abandoned as overly prescriptive and overly focused on the synthesis as artifact rather than synthesis as cognitive process. However, relevant terms associated with learning, creation, and categorization carried over into subsequent coding for this third iteration design. These include concepts from rhetorical invention scholarship, as well as selected works drawn from the field of cognitive/neuroscience as captured in neuroeducation scholarship (e.g., Tokuhama-Espinosa; Segev-Miller; Jonassen et al.; Kozminsky et al.; Adams).

At the end of the semester, only the Intervention group was asked to complete an anonymous, Likert-scaled reflective questionnaire designed to prompt personal assessment of their ability to synthesize materials in their research writing. The survey (a copy of which is found in Appendix B) gathers information on students' perceptions regarding their approach to synthesis as a writing behavior as impacted by their use of visualization. (For this reason, the Control groups were not given this post-questionnaire.) These questions were designed to potentially point to the types of metacognitive self-reflection that may be associated with

student agency and provided additional data nodes for coding. To provide more reflective interview-based content in keeping with a mixed-methods study, prior to the end of term, a request letter was distributed among both Intervention groups asking for student volunteers to submit to an interview *after grades were finalized*. Volunteers were offered a small compensation for their time; however, only one student responded (see discussion in Limitations section to follow).

Throughout this process, an additional data resource is provided by a memo writing journal I maintained throughout the study. This memo writing chronicled classroom processes, unexpected variances, ongoing reflections on students' engagement with the intervention, and, when possible, notes on theoretical connections as well as thoughts on future iterations of the intervention. This provided me with a reflective archive as well as a way to track any emerging patterns, codes, and categories for data analysis.

Data Collection & Coding

DBR-Based Methods for Data Collection & Coding for Analysis

This chapter will present the data coding process and coding results gleaned from the intervention. As a mixed-methods study, there is a great deal of data to sift through and present in this chapter. I used a dual-step coding process guided by my research questions to look for any potential patterns of association that might be discussed in terms of intentional/creation processes, using Simonson's framing definition of invention as "thinking, looking, doing" (314), as well as terms of structural knowledge (Jonassen et al.). My coding process also allows for any potential indicators of agency (intentionality and meta-awareness of meaning-making efforts), as well as potential signs of correlation to their subsequent text-based synthesis drafting efforts; student recordings and journal entries provide such sites. Observations of students' design

decisions in their mapping are also included for coding, as such visual choices may suggest metacognitive traces of both agency and meaning making, where “representation is a *construction*,” a notion supported by Flower’s lens of cognitive rhetoric that frames “writing in terms of actions more than text” (“Reflection” 334-335; emphasis added). As a potential site of metacognition and creation (key components of synthesis writing), students’ DCMAPs may also capture representations of student attitudes toward research writing, knowledge creation, perceived agency, and reflection on the usefulness of such maps as part of their synthesis-as-cognitive process. Pre- and post-questionnaires, as well as reflective tools (journal entries and interviews), are used to code for these areas.

A number of data-generation protocols are employed in this study to capture both the granular “how to” process data but also the actions of transfer and translation that might “generate traceable associations” when coded as nodes of student agency³⁰ in creating and reflecting on mapping (Latour 108). Because my study is predicated on the assumption that student synthesis is more productively taught and learned as cognitive invention processing (as opposed to textual artifact or goal), such traceable associations made visible via concept mapping as a form of data can help me explore that point. Because my theoretical framework views rhetorical invention from a constructivist perspective, the DCMAP is a designing, composing, and reflection environment constructed by and for students, rather than used as a pre-constructed “instructional tool” for “delivering content” (Donaldson). Therefore, my early coding processes focus on “construction of meaning” and the practices involved within that space. This approach is reinforced by varied scholarship that promotes pedagogy that situates learners as designers of

³⁰ See the Introduction for my operational definition of student agency.

knowledge (Purdy; Jonassen and Reeves; Bruillard and Baron; Cross; Hay et al.; Johnson-Eilola and Selber).

I relied heavily on Saldaña's *Coding Manual for Qualitative Researchers* to guide my coding processes because of the text's in-depth and accessible approach to flexible multi-stage coding techniques and patterns. To assist me in coding artifacts included in my mixed methods study, I also drew upon the work of Segev-Miller ("Discourse Analysis") for key definitions of concept/concept-building to inform my coding terms. I also looked to the methodology of Campbell et al., whose 1998 work applied Biggs and Collis' SOLO taxonomy ("structure of observed learning outcomes") to characterize three levels of "cognitive structuring" in student conceptualization of writing processes and outcomes (450-454). The measurement tools for coding that emerged from these resources are included as Appendix A.

The Process

Coding and analysis of student writing and DCMAP artifacts retained in the Blackboard and Mindomo spaces took place after the end of the semester, after grades were posted. Analytical memoing took place while the study was still on-going, as well as during the coding process. Such memoing provided an opportunity to capture ongoing hiccups in the lesson plans (of which there were many), as is representative of the very "messiness" of the classroom environment that led me to adopt the DBR framework for my methodology. This memoing also provided opportunities to record ongoing observations at each stage that would become part of the data coding at the end of the intervention study. In the data analysis stages of my research, the types of data gleaned from a mixed methods' approach were coded to locate nodes of influence from Rhetorical Invention theory, as well as Design and Cognitive Theories.

As a DBR study, this complex, emerging framework (what I began to call a Frankentheory) and the evolving intervention design inevitably presented interesting offshoots thanks to the influence of relevant interdisciplinary threads of my graduate work at Old Dominion. In particular, theories that influenced my emerging thinking during design were provided by a mashup of scholarship from educational sciences (like Activity Theories and their emphases on agency and engagement) and brain/cognitive sciences (including MBE). These influences led me to frame the associational meaning-making potential afforded by the DCMAP's design features and students' writing practices in terms of processing as networks of behaviors and beliefs (Latour; Cooper), rather than flattening student writing efforts by framing them as *artifacts* of an intervention. In this light, concept maps are quite literally a type of constructivist tool that facilitates the types of data-generating and gathering I needed to explore synthesis as cognitive invention process and CMAPs as a space to examine that process unfolding. My coding choices reflect Villalon and Calvo's definition of concept maps as "[c]ognitive visualization tools that make 'thinking' visible, reifying learners' mental model about domain knowledge onto an explicit graphical device" (16). When framed—as I do in this intervention study—as “facilitat[ing] the development of metacognitive skills” (23) promoted by composition's core philosophies informing pedagogy and classroom writing assignments, this clearly becomes a desirable data node. But how to measure metacognition happening “in the wild” is not so simple. Indeed, it is an obstacle explored by scholars in studies ranging from rubric approaches (Lundstrom et al.; Oakleaf) to concept counting and discourse analysis of texts and student voices (Howard and Jamieson; Segev-Miller; Bizup; Flower and Hayes). Applying a DBR approach to data gathering and coding allows for such complexity and led me

to develop three coding and measurement tools shaped by the strategic theoretical areas informing my research (see Appendix A).

Data Collection: Sites & Rationale

Traceable associations (Latour) become visible by deploying a DCMAP as a composing space, which provided me with opportunities to explore and collect data on student connective and discovery efforts as inventional moves. These associations occur in non-visual spaces as well. Therefore, this study's design includes four areas of data collection: (1) indicators of agency and pre-existing knowledge (questionnaires and journals); (2) the DCMAP construction and design (maps and journals); (3) process and reflection tasks (journals, mapping, drafting); and (4) instruments of writing as designer (interviews, mapping, written synthesis passages, final essays). As previously mentioned, the DCMAP is one of the most important of the data sites I looked to for possible indications of student metacognitive and process experiences as they visually represent, translate, reflect, and recursively transform the particulars of source materials located as part of their research. These graphical and conceptual data points represent potential abstractions of students' cognitive processes and associations (Cooper's "virtualities") as they materialize through the connective affordances of DCMAP features. Such framing creates diverse areas of potential data generation, a hallmark of a mixed methods study.

For example, students' DCMAP structural choices (e.g., node color and shape, connector line forms and weight, spatial positioning, media elements) become one set of data to examine based on theories of CMAPs as cognitively constructivist and representational spaces (Donaldson; Willis and Miertschien; Villalon and Calvo; Emig; Novak and Cañas). Such theories suggest that these choices serve as enactive tools to reflect *student* knowledge (not merely source knowledge) in terms of their own reasoning and agency in construction. A CMAP

is a “knowledge representation tool” (Novak and Cañas 28) that is based on an understanding of mental models (schema) in constructivist terms. Adams writes such modeling “shape[s] what we can accomplish and how we do it” (10), which echoes Edwin Hutchins’ explanation that these tools serve as “representations” that “mediate” cognition (117). Because synthesis requires acts of transformation, another source of data emerges by examining the progressive, semester-long DCMAP construction work in Mindomo for what Hay et al. refer to as snapshots of the progressive stages or moments of learning (304). Any changes to the graphical structures in the map become additional data to analyze. The digitally-based CMAP program Mindomo allows users (student and teacher) to review a history of the map’s making, allowing me *and students*, in a co-creative capacity, to examine visual snapshots of students’ processes and discoveries and correlate these to their research discovery journaling to look for any potential patterns for comparison. Other data sites were chosen for their potential to highlight possible synthesis/invention features as markers of agency, transformation, and metacognition. These sites are journal entries, questionnaires and interviews, and written synthesis passages.

Coding Strategies

Given the varied nature of the data types collected, a Descriptive Coding approach (Saldaña 292) seemed the most reasonable and sustainable approach for the first cycle of coding. It is also well suited for the exploratory nature of this study’s examination of the interaction of the intervention and student inventional and synthesis processes across varied modalities of creation. However, for the pre- and post-questionnaires, Magnitude Coding was applied to look for any potential presence or directional trends over the course of the intervention. Looking at the mapping process through a design lens as filtered through a DBR Methodology, I elected to follow a purposeful data sampling process, as explained in Antoniadou’s report on “Collecting,

Organizing, and Analyzing Multimodal Data Sets.” This would allow me to manage the multimodality of the data available to identify and collect, and do so within the limited time frame of a single semester. This led me to apply a criterion-based coding approach to manage the rich diversity of the data during my second cycle coding. This became especially important in choosing data that correlate key components of the intervention’s process orientation: map use, journal use, and final essay submission. This also allowed me to avoid the risks of any bias in sampling that might occur by cherry-picking student examples.

My goals for coding were to capture varied indicators or markers of creation and cognitive processing (both synthesis components), as well as factors of agency in terms of students’ pre-existing knowledge. I focused on construction (structural) behaviors or markers, including vocabulary that occur as “repetitive patterns of action” (Saldaña 6) to represent assembly and connection behaviors (action and thinking processes) in either textual or map artifacts. These terms became useful in characterizing “what was happening” as a process-based lens through which to identify emerging patterns for coding. These lenses are based on my research questions and follow an active learning/constructivist approach, and are represented in Figure 5 below.

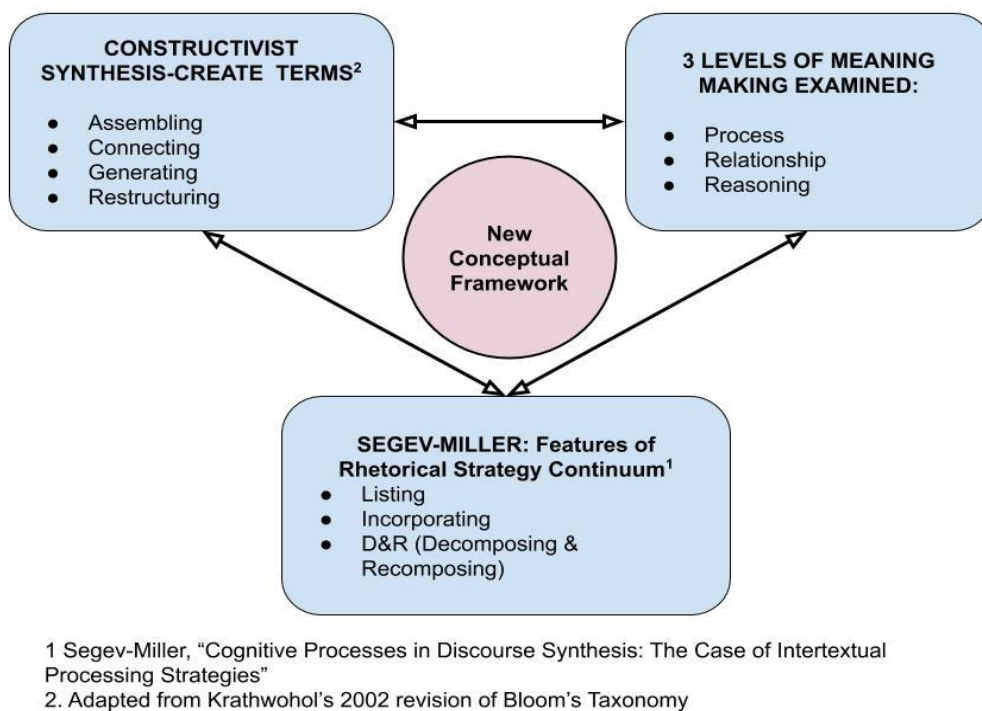


Figure 5: Research Question Generated Lenses for Coding

These terms represent the types of student behaviors and choices—both cognitive as well as writing processes—that are highlighted in my Literature Review, and in particular our field's work in Rhetorical Invention (Atwill and Lauer; Crowley; Arthos; Emig; Young and Liu) and intersecting related scholarship from other fields that investigate the cognitive (Boscolo et al.; Flower; Battro et al; Fischer; Hardiman; Willis; Sousa). Combined with recent studies on synthesis by Segev-Miller, Barzilai et al., Boscolo et al., and Kellogg and Whiteford, this research led me to identify three categories for coding (Processes of Invention, Relationship Building, and Meta-Reasoning) that would allow me to explore the constructive features of synthesis-as-cognitive-invention within several data areas, including the DCMAP, student narrated reflections and writing journals, and research essays. Table 2 below represents these areas of categorization as lenses for coding.

| Process of Invention | Relationship | Meta-Reasoning |
|--|---|--|
| <ul style="list-style-type: none"> ● Summary ● Listing ● Discovering (“I see”) ● Constructing (“I made”) ● Making new connections ● Sequencing (“1st, 2nd”) ● Changing ● Knowledge Telling* ● Knowledge Transferring* | <ul style="list-style-type: none"> ● Relating ● Structuring ● Comparing ● Scaffolding (adds, etc.) ● Patterning/Grouping ● Causing (leads to) | <ul style="list-style-type: none"> ● Understanding ● Representing ● Thinking ● Believing (“I believe”) ● Reasoning (“because”) ● Narrating |

** These two terms are drawn from a number of composition scholars whose work influenced my own, including Kaiser Lee; Kellogg and Whiteford; and Segev-Miller.)*

Table 2: Areas of Categorization as Meta-Lenses for Coding Features of Construction

These coding categories are also reflected in terms used in the classroom or in classroom materials in discussions of research and synthesis, reinforcing their presence in these processes.

Table 3 below demonstrates the additional sub-categories related to these meta-lenses representing three areas for coding that I align with student agency, an essential consideration from my research questions.

| Student Agency | Creation Language | Synthesis Moments |
|--|---|--|
| <ul style="list-style-type: none"> ● Pre-existing knowledge and habits ● Moments of the meta: in vivo attitudes or values that affect or emerge from the process and “buy in” ● Personal process behaviors (how they like to write, successes, struggles) | <ul style="list-style-type: none"> ● Discovery (“seeing”) ● Construction/Building ● Making (relationship building) ● Inquiry (questioning, exploring) ● Designing (map media features) ● Process ● Representation (visualization, conceptualizing through relational map features) ● Mental model/schema building | <ul style="list-style-type: none"> ● Relation Terms: Vocabulary List use ● Behaviors: changing over time (from Listing to Incorporating to D&R) ● Concept Formation ● Reporting vs. Transforming (knowledge telling or listing vs. knowledge creating) |

Table 3: Sub-Categories of Meta-Lenses Used to Code Data for Markers of Agency

Coding efforts began with pre-coding collected artifacts, including: questionnaires, sampling of student journal entries targeting reflective map use and early synthesis drafting passages, the full Mindomo map, and submitted final research essays. Coding methods used in my first pass were a mix of primarily Descriptive approaches, specifically the types of Structural, Descriptive, and Process methods described in Saldaña’s *Coding Manual*. I applied In Vivo coding methods to annotate and capture student voices and agency in data collection methods like the pre- and post-questionnaire responses and the reflective journaling. This choice allows me to identify early student agency and prior knowledge/values, as well as feelings towards the writing process (using maps, writing, researching confidence). These may offer clues as to potential for student buy-in or “learner disposition” toward the intervention itself. As “buy-in” does have an impact on cognitive process, this factor seems worthy of consideration when examining the data (Boscolo et al. 420).

The Process Method approach to coding (as described by Saldaña) was essential for the nature of my interventional study to help me locate “what is happening here” in student writing (journaling, essay writing) and mapping, as well as in analytic memos. This choice also creates a

way to explore how observations made about one set of data might correlate to what was observed in another set of data. Choosing gerund terms to “connote action” allows me to account for both observable artifacts like student design choices such as color or connector line directions, as well as capture “conceptual” elements like “struggling” or “representing” that may suggest cognitive processes at work (Saldaña 111). As my research questions focus on invention as a cognitive process, I needed to choose coding methods that would capture emergence and application over time, as well as highlight features or conditions of the intervention that might “slow, impede, or accelerat[e] the process” (Saldaña 114). To help me frame this as a process, I drew heavily upon the work by Segev-Miller on discourse synthesis, and especially her design of a Synthesis Continuum. In addition to In Vivo coding, I also applied the Aspect Method to review the pre- and post-questionnaires and reflective journals to capture student views and values. Attribute Coding was used to tag relevant variables of the study (Control/Intervention), but more importantly, student participation in the process itself (completing all, some, or none of the prewriting activities related to the interventional process). These attributes were assigned as illustrated in Table 4 below:

| | |
|--|---|
| Role Attribute: Experience With Maps | <ul style="list-style-type: none"> ● Prior use/Experienced user ● Novice user |
| Topical Markers: Completion level of Narration Premapping (NP 1-3) Journals [0-2] | <ul style="list-style-type: none"> ● 0 = no premapping, ● 1 = some premapping, ● 2 = all premapping |
| Magnitude Coding: applied to assess the degree to which a behavior seems to occur | <ul style="list-style-type: none"> ● Frequency (often, somewhat, not at all) ● Presence/Absence/Unclear ● Evaluative: complex vs. simple ● Intensity (pre-/post-questionnaires) |

Table 4: Attribute Coding Used to Identify Student Participation in Process

Coding Data Sets

Coding for Pre-Existing Knowledge and Agency-Related DCMAP Reflections: Data Set 1

As previously mentioned, both pre- and post-questionnaires were collected from the Intervention group (n=35), while the Control group (n=34) submitted only the pre-questionnaire. These were coded using both In Vivo and Aspect methods, as described previously, following an Exploratory/Descriptive approach. The pre-questionnaires consisted of eleven (11) Likert-Scale questions, one (1) Rating-Scale question, one (1) Short Answer. The Likert-Scale questions were designed to capture data on (1) prior knowledge, (2) student agency, and (3) meta-cognition. The questions addressed three areas of pre-knowledge or experience: working with sources, synthesis behaviors, and views of their own knowledge authority when writing a research essay. There were also three questions about previous experience using graphic organizers. Post-questionnaire surveys were only distributed to the Intervention Group, and out of the original 35, only 24 were returned (n=24). (This variance is a reflection of students dropping or failing the course.) The post-survey consisted of ten Likert-Scale questions on students' assessment and perception of their concept map use as part of their ongoing research writing and synthesis practices.

In preparation for coding the pre-questionnaire results, raw category numbers for questions 1–11 were tallied. The final two questions (the individual perspective and the short answer questions) were coded separately. The next step was to correlate these individual perception responses (Q11 and 12) for trend or pattern analysis when compared to the Likert-Scale questions. The post-questionnaire results were simply tallied numerically for each question and category of response. In my early review of questionnaire results from the Intervention group, I noted in my memo record that there were no provisions made for any way to correlate the post-questionnaire results to individual map work to see if there were any parallels between students' engagement in the mapping process and their agree/disagree response ranges. This will likely be considered in future iterations or be the basis for a future research project.

Coding for Constructions: Data Set 2

After coding the questionnaires, I turned next to student reflection journals. My early coding annotations accounted for/reflected a process of knowledge creating. Hash marks were used in complex passages of the full essays to differentiate passages that appeared to represent student voice (a potential marker for agency) from source voice—although in some cases this was difficult to do accurately as student citation practices were still emerging and/or inconsistently applied, making it difficult to clearly discern with complete confidence. These annotations allowed me to create a representation of process, from individual pre-existing knowledge to emerging synthesis practices. Other annotations that emerged during first-pass coding were designed to represent passages of knowledge as a constructive process, ranging in progressive stages of cognitive complexity from personal/pre-existing to macroproposition³¹/new conceptual constructions. These are illustrated in Table 5 below.

³¹ Segev-Miller, "Writing From Sources," pp. 6, 21.

| Code | Represents/Is a Marker For |
|-----------|--|
| Kp | Pre-existing knowledge (beliefs, I think, I know) |
| Ko | Others' knowledge (source ideas, interviews, field research) |
| KD | Developing knowledge (shows, learning, reveals, proves, adds, means) |
| KC | Combining knowledge (juxtaposes but little to no weaving) |
| KN | New knowledge (result of their encounter with Ko, meaning making) |

Table 5: Coding Labels for Markers of Knowledge Construction as Process Across Data Sets

These five labels were used because of their portability to other data sets (e.g., the DCMAP spaces) for any sign of parallelism or transfer. Because many of these student journals reflected on map use, the labels were applied to both narrative passages and representational design choices.

To highlight more structural behaviors, I used color coding to capture what I came to refer to as Pc (Process Conceptual) or PR (Process Rhetorical). The PR label indicates types of behaviors that represent rhetorical practices or structural features, such as outlining, thesis structure, building evidence, argument features, etc. The Pc label represents types of behaviors that suggest the student is using terms associated with a conceptualizing process, such as reflective designing, relationships, representation, or visible thinking (e.g., “helps me see”). The color coding of journal passages followed this pattern and is represented in Table 6 below.

| Color Coding | Process Behaviors |
|---|---|
| Melon | previous experience |
| Purple | structural or organizational (rhetorical) – includes genre-related moves of argument (appeals, proof) |
| Blue | construction process, designing (conceptual) |
| Yellow | reflection voice, meta (why, how, I believe) |
| Orange | Relationship vocabulary: simple |
| Green | Relationship vocabulary: complex |
| Pink | Design/Visual choices or representation elements |
| Double colors were used to “lump” passages that seem to represent an emerging pattern of cognitive behaviors enacted in writing or map designing choices | |
| Green and Blue | Meaning Making seemed to occur |
| Orange and Purple | Reporting Knowledge |
| Green and Orange | Synthesis |

Table 6: Color Coding Used to Mark Journal Passages for Highlighted Structural Behaviors

Out of these early coding efforts, there emerged three broad categories: (1) process, (2) relationship, and (3) meta-reasoning or complex construction (expanding, conceptualizing, restructuring, “big picture” development). The Process Category, coded purple, includes: seeing patterns, construction processing, sequencing (and variants of). These might also include listing practices (one of the earliest stages on Segev-Miller’s Continuum). The Relationship Category, coded green, includes variants of rhetorical thinking (claim types, believe/because), associating,

simple meaning making (translating, summary, this means, she means), linking/connecting. The Meta Reasoning/Constructing Category, coded orange, highlights representations of expanding, interpreting, conceptualizing, designing big picture, and restructuring knowledge. These are signs of complex meaning making, as described in Segev-Miller’s research study on discourse synthesis practices of student writers. In my own coding, I incorporated several of the “processing strategies” labels used by Segev-Miller in her creation of a “Rhetorical Strategy Continuum,” including Summarizing [S], Listing [L], and Decomposing & Recomposing [D&R] as they seemed to capture the most common pre-synthesis behaviors among student writers (“Cognitive Processes” Figure 1, p. 18³²).

The vocabulary terms signifying Relationships or Construction (areas marked using the aforementioned methods) were drawn from the following resources, illustrated in Table 7.

| Source | Details |
|---|----------------|
| The instructor-generated vocabulary & concept handout | See Appendix D |
| Instructor-generated journal prompts | See Appendix D |

Table 7: Resources Used for Coding Vocabulary Terms Signifying Relationships or Construction

³² Permission for adapted use granted by original author via email, dated 2 August 2019. A copy of this email is included in Appendix E.

| | |
|---|---|
| Concept Map features | <ul style="list-style-type: none"> ● Labels/Label Boxes ● Text content in Nodes |
| Journal Entry contents // Mapping elements | <ul style="list-style-type: none"> ● Same or Synonymous terms ● Parallels in construction or process concepts expressed ● No transfer/parallelism at all |
| Assignment language | See Appendix D |
| Student perspectives or views of map use and representational reasoning | <ul style="list-style-type: none"> ● Reflective journals ● Narrated journals ● Post-questionnaire ● Interview |
| Process & Construction phrases | See Appendix D |

Table 7: Continued

In terms of the features examined for possible parallelism or transfer, I looked for design and construction affordances of the DCMAP platform and designing/construction choices made by students that might suggest potential for representation as a cognitive processing behavior. Table 8 below illustrates the sources I looked to for these design and construction affordances, and the specific representational markers coded for analysis.

| Source | Representational Markers |
|-------------------------|--|
| 1) Map images | <ul style="list-style-type: none"> ● Lines ● Colors ● Labeling (for purpose & relation) ● Multimedia use |
| 2) Journal Content | <ul style="list-style-type: none"> ● Labeling terms ● Draft paragraphs ● “What is happening here?” passages |
| 3) Final Research Essay | <ul style="list-style-type: none"> ● Connection/Labeling terms ● Organizational patterns ● Synthesis Continuum features |

Table 8: Resources Used for Coding Design and Construction Affordances as Markers of Representation as a Cognitive Processing Behavior

As I continued with early coding, I noticed some of my codes were insufficient, incorrectly labeling *types of knowledge* I wanted to describe and differentiate. I began with a tiered series of behavior terms meant to represent *stages of the synthesis process* as described by Spivey and Segev-Miller: (1) collecting, (2) organizing, (3) transforming. Since I also wanted to take into account student *agency* (in the form of their pre-existing knowledge/beliefs), I added that as a key behavior term. This is in line with the course activities, in which students began the scaffolded assignments with a Topic Exploration project based on their own experiences and wondering. This then translated into a DCMAP in-class activity during week 4 when first design efforts in their maps included only “I believe” and “because” premises as nodes, reflecting only student’s knowledge of their topic—no research. This led to the codes Kp (pre-existing knowledge/beliefs) and Ko (others’ knowledge). I then created KD to signal what seems to be Developing Knowledge (a process or a noun), suggested by student use of terms like “shows, reveals, proves, adds, means.” These come from the Relationship Building Vocabulary sheet provided in Week 9.

KN represents New Knowledge, used for phrases that signify student encounters and engagement with source materials, including attempts at meaning making and macroproposition building or “conceptual transforming” (Segev-Miller “Writing From Sources” 21). As I coded, however, it became clear to me that I was missing an intermediate level between KD and KN. So I created KC to signify Combining Knowledge, students’ efforts to *juxtapose* (but not necessarily *integrate* in meaning-building ways) source ideas with their own. An example of this would be a student’s use of a “what this means” passage immediately following their representation of source material. This early coding led me to categorize what I was observing into two categories of Knowledge Transforming: Knowledge Translating vs. Knowledge Transferring. Knowledge Translating appears when students offer a simple explanation of “what this means” in a way that often simply interprets by rephrasing the original source ideas or merely duplicates by restating or juxtaposing source ideas (KC or KD), without any significant transformation into new knowledge (KN). Knowledge Transferring, however, serves the writer’s emerging argument by creating a macroproposition, using terms like “reveals, demonstrates, illustrates, shows/points to.” This is more cognitively active and suggests an inventional-synthesis is occurring. This type of meaning making seems to appear whenever KD and KN are both represented. This coding label is important because transformation of knowledge (Campbell, Smith, and Brooker³³) may *begin* as students combine knowledge (KC) but can really only occur in their creation of a macroproposition, or New Knowledge (KN). Marking student writing by using these codes provided me with a common terminology to begin data triangulation.

³³ Campbell et al. explains these terms used in my coding schema: “the 3 intermediate levels of response: unistructural, which focuses on one relevant element [like integrating only one source in synthesis, or two but leaving out student voice]; multistructural, in which several relevant independent elements are used in sequence; and relational, where elements are integrated into a coherent structure” (450).

Coding the Visual: Data Set 3

Mixed methods strategies are common in composition scholarly data coding, typically focusing on artifacts of writing or think-aloud reflections on writing. My study necessitates a visual lens as part of this. Concept mapping as a constructive and cognitive processing behavior “makes use of dual coding; that is, the students learn the material both from the text labels found on the concept map as well as the visual structure of the map” (Morton). Designing and coding for the visual elements of the DCMAP as a primary locus of this study proved to be challenging (see Appendix A: Visual Design Features of Map); interpreting what a student writer “means” when choosing a color or a directional arrow falls into the somewhat gray area of conceptualizing representational thinking. This is why part of the data captured for my analysis comes from student-narrated stages of his/her mapping in screen capture videos. However, despite instructions to the contrary, I discovered that students often focus on the content of their research *assignment* steps rather than the “why” of their *design choices* as they narrated their maps. This may reflect the dominance of prior experience with map heuristics as an organizational tool (not unlike an outline) rather than as an inventional discovery tool. This lack of consistent student voicing of the “why” of a mapping design choice throughout the semester’s work leaves significant gaps. (This is discussed further in the Limitations section.) Thus, other journal entries not directly connected to specific mapping moments of developing students’ arguments and writing processes were included in the data collection, providing some additional context for student creations in the map space.

Still, this idea of “student visual representation choices” is an important element to my reasoning for positioning the DCMAP as an interventional space, and capturing data that points to this element of the creation process and cognitive process was an important goal of the study.

The visual data set also correlates to all three of the meta-areas of this study (process, relationships, reasoning), giving me a clear correlative opportunity for coding and analysis. However, some of the observations gleaned from my early data coding and analysis of student journaling about concept mapping points to the ambiguous nature of visual representations. For example, even though several student journals indicate their color choices for nodes as they created their maps were based on how much they simply “liked these colors,” even that choice suggests a judgement and intentionality when it appears more than once. There is meaning associated with that choice—the question is, does that meaning carry over to the assigned content of that node in some way that suggests it might play a role in the student’s treatment or understanding of potential correlations or relationships to other nodes in the map?

This is tricky: what the researcher thinks a design element choice “means” in terms of representational or associational value may not be exactly the same as what the writer “meant.” It is tantamount to “reading the student’s mind.” This is the reason one of the data artifacts for this study is the reflective narrated captures of student mapping progress, in the form of brief audio-visual recordings submitted as journal entries. These entries asked students to narrate both their map’s content and their inventional thinking processes in its creation (“what happened here”) in the process of building this phase of their maps. This audio narration was submitted with a screenshot of the map features at that moment of construction in the form of either a PowerPoint file (image + voice-over) or a screen recording using an open source program like Screencastify or Screencast-o-matic. (As I mention in the Limitations section, these variables also included a handful of students who opted to simply use their smartphones to record an mp4 of their computer screens while talking). To code these artifacts, I drew from cognitive and design

scholars, as well as rhetorical invention theory, to help me process the data. Bennett et al. break this into both visual and language components for coding:

. . . visual data can be approached in the same way described for interview transcripts, focusing on content or on language. When looking for content we ask: What is depicted in the drawing or photo? What are the elements (people, animals, thought bubbles) within the picture? and How are they interrelated? When focusing on language, we are interested in the visual language used, describing, for instance, the use of shape, colour, icons and metaphors. In visual analysis, we typically combine a focus on content and visual language. We start with an open description of what is in the picture (i.e. open coding), and then proceed with comparing different pictures within the same study, looking for patterns or recurrent motifs (i.e. focused coding and categorising). (11)

Such choices are consistently used to *categorize*, a means of *patterning* that cognitive scientists discuss in terms of meaning making processes our brains follow as part of processing experiences (e.g., Hardiman; Willis). The affective meaning expressed by these students in their narration also plays an important role in the learner's associational processing efforts, a key area for observing possible transference from the metacognitive moves made in the maps to those made in their essay writing. To code for both, I again applied the annotations scheme previously listed, creating a coding pattern for later triangulation analysis and discussions of transfer.

During the intervention, students were asked to record three separate concept map narration files, one early in the process, one mid-way, and one in the final construction stages. At the end of the study, I transcribed these files, although some of them contained no audio at all due to either technology issues or user omission. These incomplete files are still included in the study's results but analyzed only as visual evidence of progress and engagement (see my notes on Limitations).

While transcribing, I was listening for both Listing [L] (the what) and Meaning Making [MM] (the how and why). Characteristics that qualified for [L] included merely reading the map content in text boxes ("telling") but providing no commentary on design or construction choices.

Characteristics that led to a marker of [MM] included students going beyond “telling” and into explaining and connecting their design and construction processes (possible indicators of inventional cognitive and construction behaviors). I began color coding passages that seemed to represent one of the three areas also coded for in students’ text-based reflective drafting journals: Process, Relationship, and Reasoning (see Table 2). Explicit mentions of design earned notes in margins.

In my final coding pass of these narrated map journals, I made a number of observations related to the intervention’s design and execution that will play into future iteration revisions:

1. Some students (a small percentage) make comments about the map helping them to “see” connections and new paths going forward, but most positive comments are about mapping as an organizing tool. This occurs despite taking steps throughout the semester to transparently integrate into class discussion passages from cognitive research about the impacts that visualization and representation have on the way we begin to see and construct new understanding.
2. I also wondered if the current iteration’s methods and materials are too implicit, making assumptions about successful student engagement (listening, reading, enacting).
3. Given the persistent technology issues that led to learning curves and audio issues, future iterations might benefit from adding additional narration journals.
4. Finally, instructional modifications seem necessary for designing reflective journal prompts. Future iterations of this element of the process may need to emphasize more agency-motivation by evoking responses more explicitly focused on the *why* of their constructive choices.

For example, the current prompt language for the week 13 reflective post asks students to “Talk about how this part of your map shows the development of your thinking about this main supporting point” (see Appendix D: Journal Prompts). This might be better phrased in more active and rhetorical representational language as “What does this choice show an audience about your thought process in making this connection?” A revision drawing upon the touchstone metaphorical theme of *journey* might also be in order: “Imagine you are explaining to your 8-year old cousin what all these design choices *mean*.” However, an even simpler approach might be in order, one that simply asks “why?”: why did you connect things the way you do? Choose from the following list of answers: (1) Because of shared language used; (2) Because of matching ideas in source materials; (3) Because of the way these objects provide support to my own thinking; (4) Because of the way I plan to organize my essays.

Coding the Final Artifacts, Writer as Designer: Data Set 4

The fourth data set consists of the students’ final maps and their final research essays. To code the final essays, I sampled submitted files and coded passages where synthesis activity seemed likely to be happening, applying a modification of Segev-Miller’s Rhetorical Strategy Continuum (Listing, Incorporating, Decomposing & Recomposing) to examine evidence of construction behaviors associated with synthesis practices. I also wanted to consider ways these smaller passages corresponded to the structural strategies of the entire essay. For this type of coding, I found the work by Campbell et al. helpful. While rather dated, I found their coding system designed to examine student writing in terms of their “conceptualization” of knowledge correlated to my own constructivist invention approach to synthesis as a cognitive process in interesting ways in terms of coding. As previously noted, their characterization of students’ conceptualization of knowledge translated into writing strategies on three levels: “unistructural

... which focuses on one relevant element [like integrating only one source in synthesis, or two but leaving out student voice]; multistructural, in which several relevant independent elements are used in sequence; and relational, where elements are integrated into a coherent structure” (450). They found that a study of the “relationship between the process of essay writing and the final structure” would in turn parallel with the degree to which students adopted a relational conception of knowledge construction (452). These labels of Unistructural, Multistructural, and Relational became useful coding terms for examining these essays in their entirety as part of the fourth and final data set consisting of the final stages of students’ writing processes.

Data Triangulation

Given the multiple sources of data (text, visual, audio) and the multiple stages of creating, some method of triangulating the “mess” was needed in order to tie them together as parts of a process for analysis. Second-pass coding choices were made with an eye toward this need. My initial effort to do this was based on creating categories of use/participation (students who completed all stages, students who completed some stages, students who completed few to no stages of mapping leading to the final research essay). The next level was to use categories emerging from early coding to locate nodes for triangulation as potential areas of transfer between process steps. These nodes could serve as areas where potential transfer behaviors might manifest considering the intervention’s purpose to detect any correlation between what happens in the student mapping process and what happens in student synthesis efforts in their writing. Because the study’s intervention is informed by both Rhetoric/Composition and MBE research, my selected areas for triangulation were labeled as strategies to allow me to capture some of the key areas of contribution: design strategies, rhetorical strategies, and conceptual strategies. This

also allowed me to categorize my analytical memo writing recorded during the various stages of this study: implementation, data gathering, and coding.

During the second cycle of coding, I found emerging patterns needed to account for all four areas of first cycle coding and focused on locating any possible areas of correlation between the visual mapping practices and writing the research essay. In order to make informed observations about potential transfer from the intervention to synthesis writing practices, I looked for repetition of what I refer to as students' cognitive strategies: (1) structuring strategies, (2) associational strategies, and (3) meaning making strategies. These strategies and coding patterns observed are summarized in Table 9 below.

| Structuring Strategies | Associational Strategies ³⁴ | Meaning-Making Strategies |
|--|---|---|
| <ul style="list-style-type: none"> ● Ordering, organizing, sequencing ● Listing, constructing ● Linking (see vocabulary sheet handout Appendix #) | <ul style="list-style-type: none"> ● Functional Reasoning (listing): argues, shows, similar, differs, claim types, addition ● Relational Reasoning (incorporating): how things fit together; nature of connection; agrees/disagrees ● Conceptual Reasoning (decomposing & recomposing): meta-idea based | <ul style="list-style-type: none"> ● Summarizing: Telling Others' knowledge (KO) ● Preexisting knowledge: beliefs "I think" (KP) ● Incorporating: Combining knowledge (KC) ● D&R: Idea-Driven Transforming, new knowledge (KN) ● Representation, Developing: "this shows, reveals, adds, means" (KD) |

Table 9: Markers Coded for Repeating Cognitive Strategies Used by Students Across All Data Sets

This arrangement by strategy allows me to discuss the resulting data as coded in terms of the correlational potential as "cognitive structuring of the essay content" (Campbell et al. 453).

³⁴ Adapted from Segev-Miller, with permission.

An additional second-coding effort was based on trends observed across data sets in terms of students' submitted work in the form of reflective journal submissions (numbered 2-16) and final researched arguments: (1) three pre-map journals numbered 5, 6, and 13; (2) prewriting journals on synthesis numbered 4, 7, 8, 10, 12, and 14; (3) prewriting journals on mapping numbered 2, 9, 11, 15, and 16; (4) the final DCMAP; and (5) the final research essay. For this coding pass, I needed to use Attribute Coding first to capture what students did or did not do across a process range in terms of Behavior-Experience, Behavior-Context, Behavior-Design, and Behavior-Transfer. (For a full breakdown of this coding scheme, see Appendix A: Behavior Attribute Coding Scheme.)

As a final contextualizing step, at the end of the second coding pass, I compiled data coding strategies and observations from my analytical memoing into a correlational graphic demonstrating what appear to be three areas of continuum: construction/creation, rhetorical, and conceptual. These three areas represent the influence of prior research studies into the progressive nature of both structural and cognitive strategies characteristic of synthesis efforts, as captured in the graphic titled "Master Code List" (see Results section, as well as Appendix A). This graphic represents the layered process orientation of my study, one that incorporates parallel areas of repetition within the data, using concepts that reflect the theoretical intersections of rhetorical invention, cognitive science, and visualization theories needed for my next stage: analysis and discussion of results.

CHAPTER IV

RESULTS

In this section, I discuss the results of the coding process, using a narrative format to better allow for the type of thick description characteristic of qualitative research. My study's first two research questions provide the larger organizational pattern for this discussion, specifically in areas that focus on student agency in terms of cognitive behavior and motivation, and on the process of transference of constructivist behaviors from map representations to text representations in terms of knowledge conceptualization. These questions ask:

1. In what ways does the interventional hermeneutic heuristic of digital concept mapping impact students' constructive epistemic abilities? Specifically, if we can teach students to view synthesis as a cognitive process of structuring knowledge, what benefits might be realized?
2. As a visual representation of students' connections and knowledge conceptualization, what role might DCMAPs play in promoting active and progressive transformation of ideas (characteristics of synthesis)?

The continuum that emerged from my second coding pass became my Master Code List, serving as the final framework for correlating and making sense of the large amounts of data generated by my mixed methods approach. This continuum represents a coding process that incorporates the primary theoretical influences recorded in earlier chapters.

As Figure 6 below demonstrates, the two-stage coding process I used revealed four major themes or patterns related to stages of a developing process continuum. These themes (represented in the second column) allow me to discuss any potential carry-over connections perceived between student writing and student mapping as knowledge building moves and map

design strategies. This second column also captures emerging concepts that became useful in characterizing results from a constructivist/active learning theoretical perspective. The third, fourth, and fifth columns point to evidence of student conceptualizing that correspond to three types of knowledge³⁵ creation and representation used to incorporate discoveries: knowing *that* or structural knowledge (telling, listing, summarizing), knowing *how* or relational knowledge (in both functional and relational terms, and sometimes early conceptual), and finally knowing *why* or conceptual knowledge (complex deconstruction and reconstruction, relational, and synthesis). The terms in column three are used to describe five rhetorical knowledge processing stages (listing, summarizing, incorporating, deconstruction and reconstruction, and synthesis), and are drawn from what Segev-Miller's study of discourse synthesis writing refers to as "rhetorical transforming strategies" ("Cognitive" 240).³⁶

³⁵ Jonassen et al. 4

³⁶ Segev-Miller also discussed conceptual transforming strategies as the third element of a trio of strategies composing synthesis behaviors: conceptual, rhetorical, and linguistic. I chose to prioritize the rhetorical strategies for coding as they provide more visible markers of student writing processes.

MASTER CODE LIST: Triangulation Continuum & Areas of Correlation

| Process Continuum | Developing Processes of Complex Concept Building | Developing Processes of Knowledge Building Practices ¹ | Developing Processes of Structural Knowledge Building | Knowledge Transforming Stages ² |
|-------------------|--|--|---|---|
| ↓ | Assembling/ Constructing | LISTING SUMMARIZING | STRUCTURAL | <i>Knowing That: telling, listing, summarizing</i> |
| ↓ | Connecting/ Linking | INCORPORATING <ul style="list-style-type: none"> ● Discovery ● Functional ● Relational | STRUCTURAL TO RELATIONAL | <i>Knowing How: seeing connections, creating connections</i> |
| ↓ | Associating/ Generating | INCORPORATING <ul style="list-style-type: none"> ● Discovery ● Relational ● Conceptual EARLY D&R <ul style="list-style-type: none"> ● Simple ● Complex | RELATIONAL TO CONCEPTUAL | <i>Early Signs of Knowing Why: grounds for simple conceptual transformation</i> |
| | Transforming/ Restructuring | Complex D&R SYNTHESIS | CONCEPTUAL | <i>Knowing Why: grounds for complex conceptual transformation</i> |

¹From Segev-Miller's Rhetorical Transforming Strategies ("Cognitive Discourse" 240)

²From Schema Theory: declarative, procedural, and structural knowledge (Jonassen et al. 3-4)

Figure 6: Master Code List: Triangulation Continuum and Areas of Correlation of Major Themes and Patterns Found in Coding Across Data Sets

This continuum serves as a means to address the first two research questions guiding my study. It also provides the means by which to begin analyzing my study's results in order to address my third research question in the next chapter: Can MBE scholarship and theories, when combined with an understanding of information visualization as a cognitive process, productively inform assignment design for synthesis and research writing in other research writing classrooms?

Within this larger organizational framework, I rely on the following questions to guide my discussion of results to detect patterns which, as described by Saldaña, might be interpreted

in terms of emerging “habits, salience, and importance” in student thinking and writing processes that might be considered evidence of transfer (6):

- Do mapping activity and design elements carry over into the students’ essay writing, and if so, which parts?
- What repeats? What correlates?
- Is there any indication that representation processing (what students practiced cognitively while deliberately making assembly, connection, association choices in mapping) impact synthesis efforts or even represent a cognitive process-based learning activity (according to Ausubel’s meaningful learning theory)?

Coding for Knowledge Experience: Data Set 1, Questionnaires

Students’ Beliefs About Knowledge & Meaning-Making

At the heart of this study is the question of whether a visually based intervention might have any discernible effect on student writers’ cognitive invention processes as they tried to synthesize varied types of knowledge for their research projects. More specifically, do these results suggest any indication that the process of *creating* a representation of their ideas and processes in the DCMAP in any way facilitates students’ synthesis-level creation of conceptual relations to promote *generation* of new conceptual knowledge constructions (the epigenetic nature of CMAPs)? As the definition of student agency used here³⁷ includes students’ ability to proactively draw upon pre-existing knowledge (as Jonassen et al. argue), results of the

³⁷ As indicated in the Introduction chapter, I apply *agency* here as it is theorized in a constructivist and cognitive-rhetorical sense, focusing on motivations of the thinker/writer. I have framed my use of the term “agent/agency” from a cognitive rhetoric perspective, in which Flower frames writing “in terms of actions more than text” (“Reflection” 335). Its importance to my study is perhaps best captured in Marilyn Cooper’s 2011 “Rhetorical Agency as Emergent and Enacted.” She writes that “Agency...is based in individuals’ lived knowledge that their actions are their own” yet “...agents are very often *not aware of their intentions*” (421; emphasis added). As a result, the CMAP intervention is intended to function, in one way, as a means of drawing those intentions to the surface in rhetorically productive (i.e., epigenetic) ways. As Flower explains, when “representation is a construction...it will lead to some marked differences in performance” (Flower “Reflection” 334).

questionnaires distributed to students at the beginning and at the end of the semester provide some insight into students' beliefs about and experiences with research writing practices and knowledge and meaning-making processes. Put another way, would these results indicate whether students identified themselves as agents of knowledge assembly (*telling* or reporting knowledge) or agents of knowledge generation as co-inventors (i.e., *transforming* or synthesis)?

The pre-questionnaires distributed to both the Intervention and the Control Groups provide important foundational information for addressing the above areas of inquiry. (See Appendix B for full questionnaires.) Post-questionnaires focused only on the Intervention group's experiences with concept mapping. The responses were grouped by themed focus: questions 1 and 6 covered invention and new knowledge; questions 3, 5, and 7 referenced understanding source concepts (macropropositions); questions 1-4 and 7 and 8 pointed to seeing patterns and constructing new ones; and questions 7-10 captured student agency and motivations in creating knowledge and macropropositions. Figure 7 below contains the Intervention students' (n=35) responses to questions 1-6 and 11; Figure 8 contains Control students' (n=34) responses to these same pre-questions.

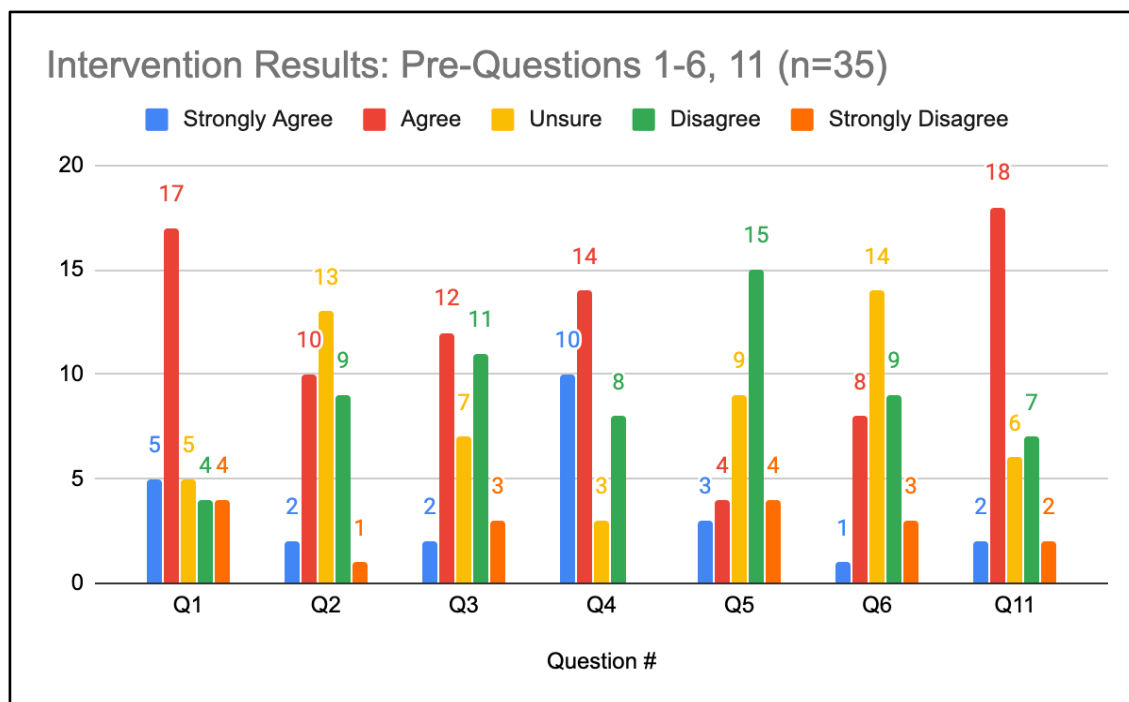


Figure 7: Intervention Group Pre-Questionnaire Responses to Questions 1-6 and 11

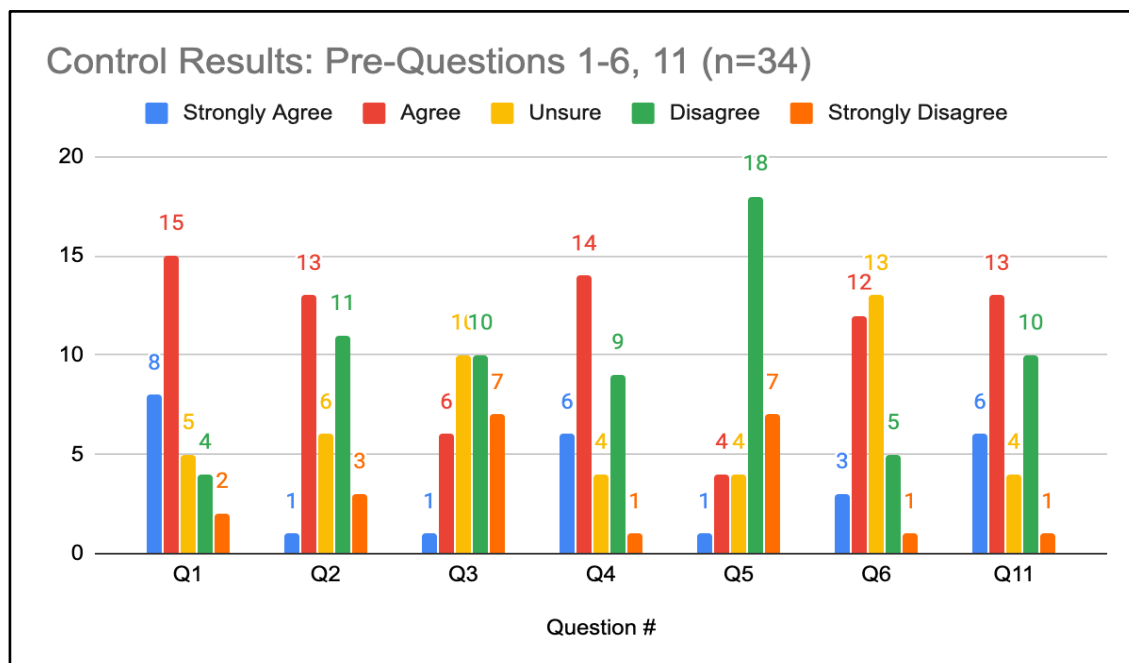


Figure 8: Control Pre-Questionnaire Responses to Questions 1-6 and 11

As seen in the graphics above, more students in the Intervention group (n=35) agreed with the statement in Q1 that personal experience and observations qualify as forms of evidence when building an academic research essay (22 agree or strongly agree, while 8 disagreed; 5 were unsure). Similar numbers were seen across all three control groups (n=34): 23 indicated agree or strongly agree, while only 6 students disagreed or strongly disagreed; 5 were unsure. Despite the very small sample size, these results seem to indicate a clear trend that suggests students' see themselves as co-inventors of knowledge, contributing their personal knowledge to a research project. However, when Q6 asks about students' knowledge of synthesis practices, the majority of Intervention respondents expressed uncertainty about their abilities to synthesize sources according to instructors' directions (14 were unsure, while 12 disagreed with the statement; only 9 agreed). The 14 responses indicating they were "unsure" if they understood how to "do synthesis" may reasonably be categorized with the number who did not agree. When compared to student answers to Q5 ("Making connections between my sources and my own ideas is difficult for me"), which points to a strategy of synthesis, the number who are uncertain or disagree (28 out of 35 students) supports this apparent uncertainty regarding their own abilities or experiences with inventing new knowledge.

Interestingly, in terms of the Control group responses to Q6 and Q5, the responses seem to flip: the number in the Control group who indicated an understanding of synthesis practice (agree/strongly agree) came to 15, while those who were unsure or disagreed came to 18, a relatively even distribution. For Q5, however, the difference with respect to the Intervention group was more distinctive: only 5 students agreed with the statement that making such cross connections was difficult, while a significant number (25) disagreed with that assessment (only 4 were uncertain). This may correspond to the patterning theme question Q8, which asks students

to assess the ease with which they “recognize” (i.e., detect patterns) similarities and differences between sources, from Always/Usually or Sometimes to Never/Not Sure. The Control group’s numbers seem to reflect the trend of their answers to Q5: 27 state that they always or usually find the task easy, while only 5 report this occurs only sometimes and 2 record a negative response (never or not sure). In contrast, the Intervention group’s responses to Q8 favor the Always/Usually response (25), with 12 responding with Sometimes; only 3 respond negatively. In this question about the ease of detecting patterns among their sources, it seems the two groups are reasonably similar, but when it comes to *creating* patterns between sources and their own ideas, the “ease” factor is less sure. Whether this contrast between the Control group and the Intervention group is due to variables beyond the control of the study is unclear. As synthesis is often explained as “creating something new” by instructional materials, this might suggest that these students are expressing a low confidence in their agency as meaning-makers in terms of pre-existing habits and process behaviors.

In terms of agency, several questions (2, 7-11) ask students to consider their own writing and discovery processes, including the use of graphic organizers. Beginning with prior experience with research writing overall (Q2), the two groups were fairly evenly distributed in their assessment of the difficulty of that task, suggesting a cross-section that may reflect both affective and/or practical experiences. In terms of agency as their process of discovering new knowledge (“something new I didn’t know before”) through synthesis (the *discovery* feature of invention), the majority of Intervention responders answered Q7 in the affirmative (27 of 35, or 77%), with only 8 of 35 (or 23%) responding in the negative. The Control group was similarly distributed more heavily in the affirmative of 26 of 34 or 75% (positive being Always/Usually/Sometimes) and only 2 as negative; 4 were unsure (accounting for <10%).

Several questions on the pre-questionnaire pointed toward conceptual levels of meaning making, such as Qs 3, 5, and 7. Conceptualization is acknowledged as the most difficult element of the synthesis process, and can be discussed in terms of the cognitive processes of synthesis-as-invention. Students' ability to understand—and, in turn, transform—key source ideas (concepts) plays a critical role in synthesis thinking and writing, as Segev-Miller's study has explored. Student responses to Q5 and Q7 have been reported above; Q3 required a bit more challenging reflection from student responders. Asking whether students “use information from sources even if” unsure of the meaning of concepts was my attempt to identify the widely observed practice of quote-mining. For Q3, 14 of the Intervention students responded in the affirmative to this question (14 of 35, or 40%), while 14 (40%) disagreed; 7 (20%) were unsure. The Control groups' distribution of answers was more distinctive, with 7 agreeing and 17 disagreeing with the question, and a significant portion (10) unsure. These results are compiled for comparison into Table 10 below.

Again, Q3 was a rather tricky question to ask early in the semester, as students may not yet see a difference between source quotes (text) and ideas or concepts. This is an important element to capture in this study, I believe, because one of my study's assumptions has to do with whether first-year writers have had sufficient developmental time and experience to learn “how to” conceptualize, as opposed to merely “reporting” material from sources at a text-content level.

| Question's Concept | Intervention (n=35) | Control (n=34) |
|---|--|--|
| #9: Graphic/Visual Tools' Impact on Organization Strategies | 16 (46%) = <i>Sometimes Used</i> 17 (49%) = <i>Never Used/Unsure</i> 2 (5%) = <i>Extensive Use</i> | 9 (26%) = <i>Sometimes Used</i> 18 (53%) = <i>Never Used/Unsure</i> 7 (21%) = <i>Extensive Use</i> |
| #10: Prior Graphic/Visual Tools' Experience for Invention/Creation | 18 (51%) = <i>Affirmed prior use</i> 17 (49%) = <i>Did not affirm prior use</i> | 18 (53%) = <i>Affirmed prior use</i> 16 (47%) = <i>Did not affirm prior use</i> |
| #11: Graphic/Visual Tools' Impact on Conceptualizing | 20 (57%) = <i>Agreed it helped</i> 9 (26%) = <i>Disagreed it helped</i> 6 (17%) = <i>Unsure</i> | 19 (56%) = <i>Agreed it helped</i> 11 (32%) = <i>Disagreed it helped</i> 4 (12%) = <i>Unsure</i> |

Table 10: Comparison of Intervention and Control Responses to Pre-Questionnaire Questions Reflecting on Student Agency and Visualization Heuristic Use

As seen in Table 10, Questions 9-11 asked students about their experiences with graphic organizers or visualizing tools as they might function in their writing (Q9 organization), creating new ideas (Q10 invention), and understanding their topic (Q11 conceptualizing). Intervention students' responses to Q9—the more generalized of the three questions—suggest that the majority of students have only sometimes or never used graphic organizers to help with their paper writing (16=Sometimes, 16=Never, with only 2 indicating extensive experience with use). The range of responses to Q10 was very similar, but with more students (23) indicating they used these visualization tools as *creation* aids (“create new ideas”), with 17 responding Never and 1 Not Sure (the same number as for Q9). Results for the Control group were more distinctly on the negative side of the range for Q9, with 17 responding they had never used such organizers, 9 for “sometimes,” but 7 “always” or “usually.” Even so, the distribution breaks down fairly evenly between “never” and some degree of use. For Q10, the number of positive use responses (always, usually, sometimes) is only slightly more than the “never” responses, similar to the trend indicated by the Intervention group's results for the same question.

Question 11 responses indicate an interesting range of variations as compared to the prior questions' emphasis on "use" as a more passive tool. The word choice of Q11 emphasizes the students' *act* of visualization, a more pronounced action of "seeing" as "doing" that is meant to suggest the role of cognitive pattern building as key to conceptualization. Of 35 student responses, 20 Intervention students agree or strongly agree (57%), with only 9 disagreeing (6 were unsure). Among the 34 Control group responders, 19 students agree (56%), 11 disagree, with 4 unsure. These results may suggest students' experiences with graphic organizers seem to be more common at the earliest "invention" stage of creating and conceptual comprehension, as opposed to being an ongoing, regular writing aid.

Questions 12 and 13 were designed to elicit responses that may point to student agency as influenced by their perceived identities as researchers, specifically in terms of how they perceive their role as contributors to creating new knowledge (Sommers and Salz; Purdy and Walker). The questions presume a higher value placed upon students' pre-existing knowledge (experiences, observations) may indicate a stronger sense of agency in this process of meaning making/knowledge making, while a lower value (as compared to more traditional text-based entities of knowledge authority such as library sources or quotes from sources) may present a correlatable trend to examine in conjunction with results of concept mapping upon their final research and synthesis essays. Students in the Intervention group (n=35) consistently ranked knowledge drawn from outside their own personal knowledge or experience ("Direct from Source, Library") slightly higher on the scale of "value" (Questions 12 and 13). However, perhaps due to the small scale of the study, the differences between categories were not significant, nor were they consistent across the Control sections. Intervention students, in fact, essentially ranked Personal Experience on an equal footing in terms of least to most valuable.

The more useful results come from Q13, in the Short Answer section, that asks students to explain the type of resource they use most and why, offering a more agency-based insight into students' choices for knowledge building. In these responses, common terms that emerged included: correct, credible, fact, reliable, bias, meaningful, and "established information." Responses often indicated that more authority and credibility are granted to extrinsic sources, as "correct and . . . reliable" with "more information available." One student wrote that "personal experience and observations are heavily biased" and are therefore of lesser value than extrinsic sources like the library and experiments, perhaps diminishing students' trust in their experience-based ideas as building blocks for the macropropositions of synthesis. Yet another student observes that using personal experience "as support for your own research paper" actually "makes it easier to relate to audiences your meaning." This comment specifically points to the act of meaning making beginning with the students' pre-existing knowledge. Responses from the Control group to this question also point toward the importance of credibility, trustworthiness, and scope, but a few comments suggest that personal experience offers something the other types of sources cannot: "your own ideas and you don't have to worry about plagiarism"; "using your own knowledge to support or counter any form of writing is highly credible."

Students' Concept Mapping Reflections: Knowledge & Meaning Making

Questions for the Intervention-only post-questionnaire specifically focus on students' experiences with the concept map. The drop in the number of responses ($n=25$) is explained earlier. In Figures 9 (divided into part *a* and part *b*) and 10 that follow, I have summarized the Intervention group's responses to the post-questionnaire that reflect synthesis strategies (Q1-3 and 10), patterns in knowledge/meaning-making³⁸ (Q1, Q4, and Q5), invention as actively

³⁸ Campbell et al. 449–450.

creating new knowledge through design (Q3 and Q6), and assessment of their experience with concept mapping as a visual cognitive aid (Q7-Q10). Questions 1-3 were worded to identify engagement in three common behaviors associated with synthesis,³⁹ as defined by Segev-Miller, Spivey, and other research: organizing or categorizing ideas, making connections, and selecting relevant support. These questions emphasize the inventional practices of seeing or discovering others' ideas, as well as creating new pathways or habits of thinking, as they relate to the information-gathering behaviors of the research process.

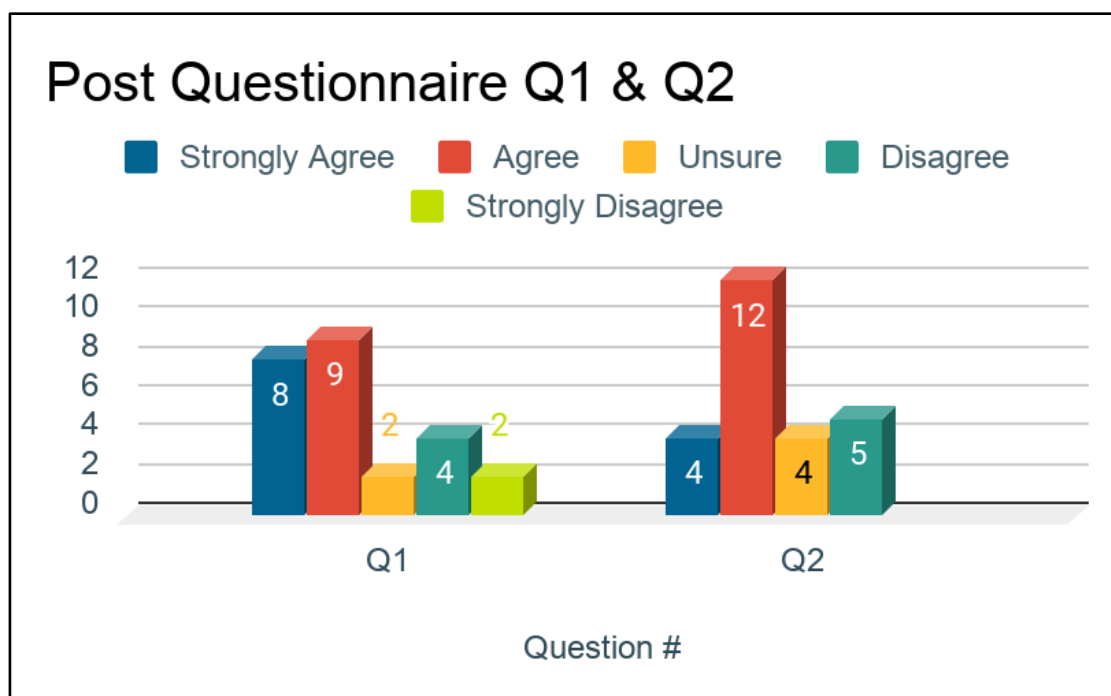


Figure 9a: Summary of Intervention Post-Questionnaire Responses Q1, Q2, Synthesis Moves

³⁹ Spivey's definition of synthesis as containing stages of organizing, selecting, and connecting ideas is frequently cited in others' studies of discourse synthesis, and so is used as a founding definition of how the reading-to-writing synthesis process has been defined ("Transforming Texts" 257).

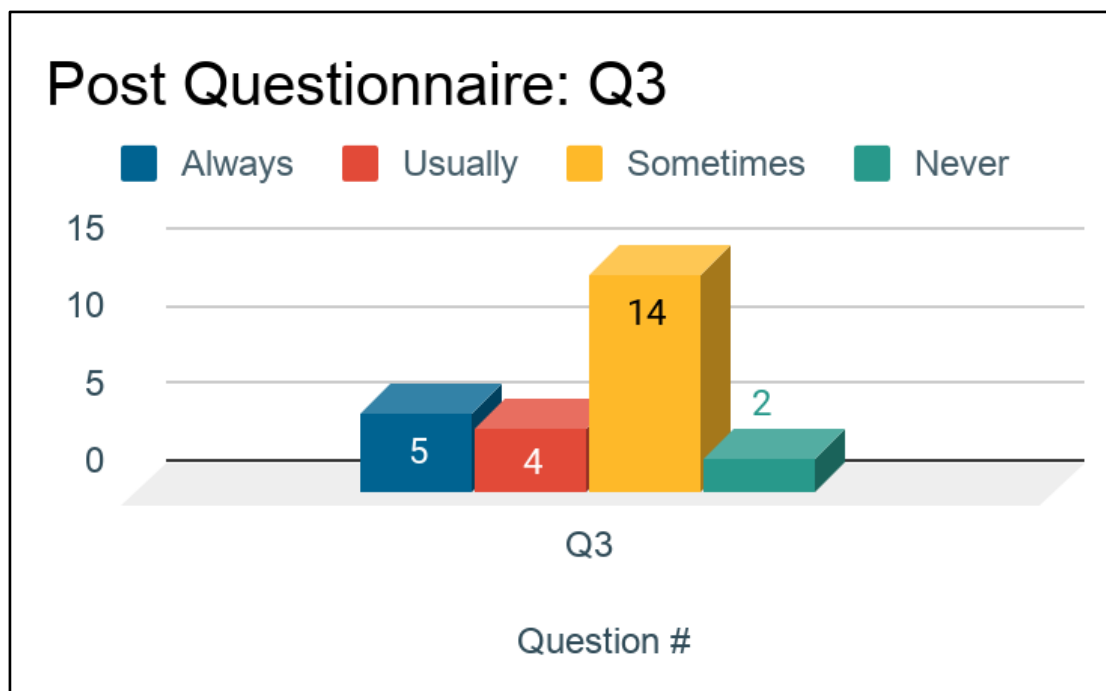


Figure 9b: Summary of Intervention Post-Questionnaire Responses to Q3, Synthesis Moves

A total of 11 students disagreed with the statements about concept mapping and sources expressed in Q1 (6), identifying key concepts, and Q2 (5), discovering new connections. However, most student responses suggest that their engagement with concept map construction did benefit in these areas (17 agreed with the premise of Q1, while 16 agreed with that of Q2). The wording of possible responses to Q3 focuses on frequency rather than agreement; whereas the wording of Q1 and Q2 suggested more agency power is afforded to the concept map as a practice, Q3 highlighted the agency power of students' active engagement with the designing process via affordance choices (features) to aid students' conceptualizing behaviors (categorizing). Student responses overwhelmingly affirm that even some engagement with the map's construction/design features benefitted their creative efforts, a rhetorical transformation function often related to conceptual transformation. This may also reflect past experiences with

graphic organizing maps for structural or organizational purposes. The number of responses reflecting uncertainty (Sometimes) may simply point to the novelty of this experience with concept mapping, a factor which may take on new meaning once triangulated with other data groups.

Question 3 also relates to the intent of Question 6, as both were designed to elicit agency-based (i.e., frequency) assessments of students' specific uses of the concept map's design functions in creating new knowledge. For this reason, the responses to these two questions are compared, as illustrated in Figure 10 that follows. In this context, Q3's use of the term "categorize" as a design choice is intended to solicit students' construction experiences as a way to build new conceptual structures. Q3 asks students to assess how often they engaged with those design choices made possible by the map's constructive features to assist their creation of visual patterns, while Q6 emphasizes the role constructive action ("creating a concept map") plays in constructing new knowledge as an inventional behavior of pathmaking ("discover new ideas to support my own argument"). Responses to both Q3 and Q6 suggest that the majority of students responded in the affirmative range (Always-Usually-Sometimes) rather than in the negative.

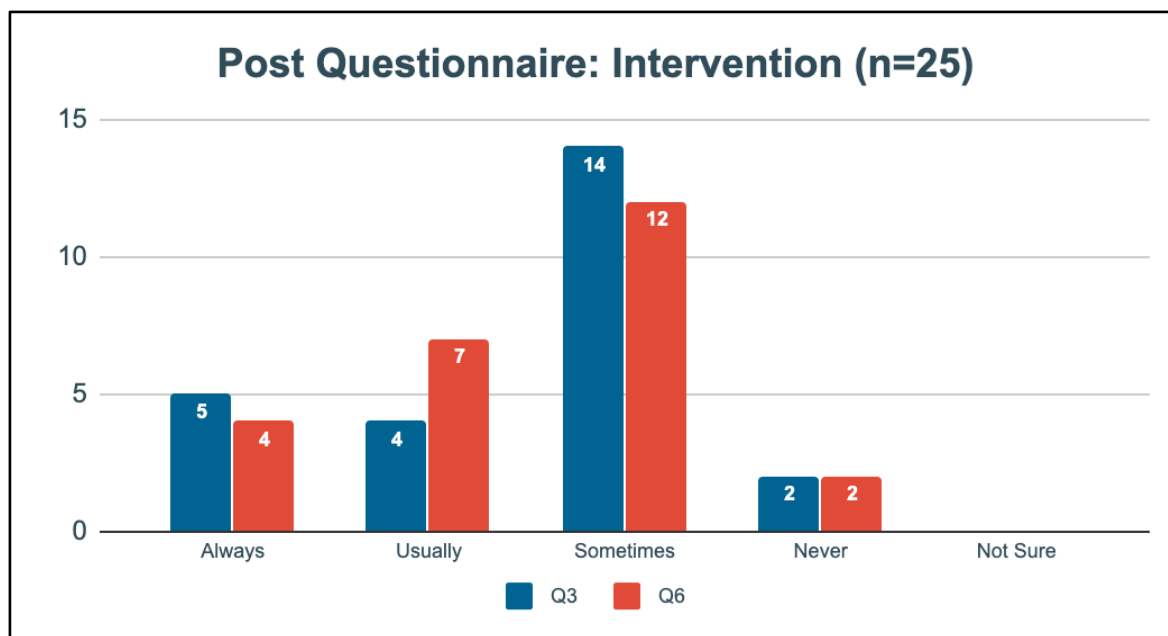


Figure 10: Comparing Intervention Post-Questionnaire Responses to Q3 and Q6, Creating New Knowledge

For Q3, this trend seems to indicate that students found using design/construction features to visually map their ideas contributed to what Spivey and refer to as one of the three primary moves of synthesis: categorizing (Spivey; Spivey and King; Mateos and Solé; Segev-Miller “Cognitive”). This may also demonstrate what Spivey, as quoted by Mateos and Solé, suggests is an indicator of students “employ[ing] their prior knowledge to process information” (436). The higher number of students who reported they only “sometimes” used these constructivist features in this way may also correlate to their relative inexperience with concept map use, as suggested by the results from the pre-questionnaire and their journal writing entries.

Question 6 of the post-questionnaire turned from a constructive rhetorical function (categorizing) to a conceptual⁴⁰ one, that of “discover[ing] new ideas to support” students’ arguments (Segev-Miller “Writing” 9). Once again, the pattern of responses is dominated by

⁴⁰ These terms reflect Segev-Miller’s continuum of synthesis strategies: rhetorical transforming, conceptual transforming, and linguistic transforming.

affirmative answers, with 11 students responding that they always or usually discovered “new ideas” thanks to the creative process of designing their maps; added to the less-confident “sometimes” response (numbering 12), this is an overwhelmingly affirmative assessment of the benefits of mapping to students’ conceptualizing behavior. However, it must be conceded that students’ may see the term “new ideas” in terms of their source materials’ knowledge rather than as their own created “new knowledge” or macropropositions (Segev-Miller “Writing”).

Pattern perception and pattern building as cognitive stages of synthesis behaviors were another area of this study’s exploratory focus, along with exploring the impact of visualization. These were captured in Questions 1, 4, 5, 7, and 8, with questions 9 and 10 providing an overall perspective on concept mapping as a learning and thinking aid. Student responses to Q10 may suggest there was room for improvement in terms of the intervention’s design, as students seemed uncertain of the connection between concept mapping and learning “how to do” synthesis. In the Intervention group, 14 indicating they either disagreed or were uncertain. Only 11 students agreed; given the small scale of the study, however, these responses do not provide a clear trend either way. A similar trend is reflected in responses to Q9, with respect to students’ own assessment of the role played by concept mapping and knowledge creation. While 15 students indicated a positive assessment of their DCMAPs’ contribution to their attempts to make meaning, 10 were unsure or disagreed with that connection.

Questions 1, 4, 5, and 7 all focus on pattern making or pattern recognition, a connective relation building function associated with cognitive processing in neuroeducational science. For all of these questions, 60-72% of the students (n=25) agreed with the premise of these questions: that concept mapping played an active role in enhancing cognitive processes of seeing and creating patterns, essential to synthesis thinking and writing. Of these, Q7 ranked lowest in these

responses, yet still trended toward a positive result (15 out of 25 agreed, while 7 were unsure and 3 disagreed). This result may reflect a degree of uncertainty in addressing the latter portion of the question, which asked them to compare mapping to reading-to-writing as a knowledge-making strategy for synthesizing ideas. As indicated by researchers Spivey, Segev-Miller, and Mateos and Solé, visually *creating* “intra- and intertextual connections” (Mateos and Solé 437) is part of synthesis development, and students’ efforts to intentionally and graphically build links between text-concepts and their own concepts—as indicated by their choices in creating graphic constructions—appear to be a traceable artifact in this study.

Examining the Writing Process: Data Sets 2-4

The patterns that emerged from my second-stage coding of data sets 2-4 provide me with a great deal of information relevant to my research questions on the potential impact of visual construction practices in the DCMAP on student synthesis processes. In fact, the sheer volume of available data gathered made triangulation efforts daunting. To frame the data into a manageable narrative that would also allow me to contrast the results with the Control group, I chose to adopt an evolutionary lens based on the continuum represented in the Master Code List—specifically, what knowledge construction concepts (rhetorical or conceptual) and types of structural knowledge building practices carry over from set to set.

From a cross-section of the total number of students across four Intervention courses (n=35 at start of semester, down to n=25 by end of term), I drew samples from three different types of student process work: journals, map work, and the final researched essay. For comparison, the Control group samples provided writing drafts and final research essays, along with some reflective writing (see Limitations section for more discussion on this). As previously mentioned, these data were chosen in order to provide me with material to examine for any

traceable associations across the process spectrum, with emphasis on the possible role visualization might play on students' synthesis and conceptualization behaviors. Specifically, I looked for emerging patterns of knowledge building or transforming across data forms. The student journal submissions were written in response to specific assigned prompts and were of two types: (1) multiple semester-long reflective journaling entries focused on writing and thinking as students progressed through the research process, and (2) three in-depth reflective recordings of students' map process stages (which I refer to as pre-mapping or NP 1-3). These latter reflections occurred at early, middle, and late phases of mapping out the progressive construction of students' researched connections, and will be discussed as a separate data set. The prompts themselves were designed to elicit four types of responses: (1) agency and experience, (2) the what, (3) the how, and (4) the why. The last three types correspond to the final column of the Master Code List, "Knowledge Transforming Stages" (see Appendix A).

To begin, in order to create a useful sampling of student work that included a full spectrum of opportunities for triangulation, I removed from selection those who did not submit a final essay. I selected 15 students, divided across the four course sections, for sampling; after the second coding pass was completed, I applied a nominal system of coding to identify the presence of certain behaviors that were being examined to address my research questions' focus on potential correlations between mapping processes and synthesis processes (both rhetorically and cognitively). For this purpose, I began by applying Attribute coding to capture the types of behaviors students did or did not engage in, and to what extent, across the process range from mapping to writing. The results of such attribute coding is inconclusive as stand-alone data; however, such coding allowed me to establish a general baseline of behaviors for possible

triangulation with other data to reveal any patterns that might suggest correlateable behaviors in terms of mapping activities and synthesis writing. Table 11 below captures the overall results.

| Intervention Pool Student # | Behavior: Previous Mapping Experience | Behavior: Premapping use (NP 1-3) | Behavior: Use of Design Features for Meaning Making | Transfer Behavior (mirroring): B/W Mapping & Final Essay |
|------------------------------------|--|--|--|---|
| 1 | 1 | 2 | 2 | 2 |
| 2 | 0 | 2 | 1 | 1 |
| 3 | 1 | 2 | 2 | 2 |
| 4 | 2 | 1 | 2 | 2 |
| 5 | 0 | 1 | 2 | 2 |
| 6 | 2 | 2 | 1 | 2 |
| 7 | 0 | 2 | 2 | 2 |
| 8 | 2 | 1 | 1 | 1 |
| 9 | 0 | 1 | 1 | 0 |
| 10 | 1 | 1 | 1 | 0 |
| 11 | 0 | 1 | 2 | 2 |
| 12 | 1 | 1 | 1 | 1 |
| 13 | 0 | 0 | 1 | 2 |
| 14 | 1 | 0 | 2 | 1 |
| 15 | 0 | 0 | 0 | 1 |

Table 11: Attribute Coding Applied to Intervention Group Sampling (n=15), Where 0-2 Represents Range from No Experience/Use (0) to Extensive Previous Experience/Use (2) with CMAPs

Coding for previous experience with mapping behaviors (Column 2) ranged from 0=no previous CMAP experience, 1=some previous CMAP experience (comments often indicate some confusion between mind mapping with concept mapping), and 2=extensive previous experience with mapping. Column 3 represents evidence of students' engagement with the Premapping journal activity, with 0=none of the 3 required premapping journals were completed, 1=some of

the assigned premapping journals were completed, and 2=all three premapping journals were completed. Column 4 points to the extent students actively used design affordances of the CMAP (colors, labels, nodes and connector lines or arrows, arrangement, etc.) to construct or assemble relationships and associations, where 0=not present; 1=somewhat present or simple representations; 2=consistently present and complex representations. The final column indicates whether features of the map transfer into students' written essay or process drafts (mirroring), with 0=features are present in one OR the other, or are not present at all; 1=some elements show up in both; or 2=significant mirroring occurs.

The last two columns emerged as the result of applying a more in-depth measurement tool, "Visual Design Features & Moves" (see Figure 11 and Appendix A). As I reviewed students' journals, maps, and final essays, I used this tool to create a picture of students' developing processes of complex concept building in terms of the major coding themes: Assembling/Constructing, Connecting/Linking, Associating/Generating, and Transforming/Restructuring (see Master Code List). This tool was especially helpful in finding correlatable processes and practices for triangulating visual elements of student mapping choices with the rhetorical and structural strategies of their synthesis writing passages (in journals and essays). It also allowed me to account for ways students were using the CMAP design affordances of nodes, connector lines, label boxes, colors, multimodal elements, and text content in terms of the three key pre-synthesis behaviors represented in the Master Code List: Listing & Summary, Incorporating, and Decomposing & Recomposing (D&R).⁴¹ For each student sampled from the Intervention group, I created a magnitude-scaled checklist applying a measurement tool

⁴¹ These terms represent a continuum of progressively complex cognitive behaviors associated with synthesis and were adapted from Segev-Miller's Continuum Terms ("Discourse").

(see Figure 11 below) that specified objects examined for coding (both visual and linguistic), using the following chart as a content guide.

| | | | | |
|--|---|---|--|--|
| Assembly / Construction | Nodes: <ul style="list-style-type: none"> • Number • Shape • Position | Connector Lines <ul style="list-style-type: none"> • Used / Not Used • Design | Label Boxes <ul style="list-style-type: none"> • Used / Not Used • Alternate Placement | Content <ul style="list-style-type: none"> • Source Knowledge • Student Knowledge |
| Connection / Linking Representation | Representation: <ul style="list-style-type: none"> • Labels • Lines • Arrows • Colors | Relation Building: <ul style="list-style-type: none"> • Vocabulary Terms • Color • Spatial • Arrows | Narration: what is happening here? <ul style="list-style-type: none"> • Here / Not Here | Narration: why <u>this</u> is happening here? <ul style="list-style-type: none"> • Here / Not Here |
| Generation [Process or Evolution] | Progressive Changes In: <ul style="list-style-type: none"> • Structure • Design choices • Content | Pattern Building: <ul style="list-style-type: none"> • Like / unlike • Pro / Con • Claim Types • I See | Themes: Big Picture <ul style="list-style-type: none"> • Course goals: Rhetorical • Student goals: Conceptual | Category Building – Organize <ul style="list-style-type: none"> • Rhetorical Product • Conceptual Product |
| Transformation / Conceptual Restructuring | Color <ul style="list-style-type: none"> • Symbolic ("this means") • Non-symbolic (category) • Other (I like) | Multimodal <ul style="list-style-type: none"> • Used • Not Used | New Directions (Category Building) | Text (E of SIEL) (non-source language) |

Figure 11: Coding Tool 3, Design Features and Moves Corresponding to Continuum of Structural and Cognitive Strategies⁴²

Coding for Constructions: Data Set 2, Student Journals

As previously mentioned, the results of my review and coding of Intervention students' reflection journals and early map use led me to apply three previously identified categories of constructive behaviors: processes of invention, relationship structuring, and meta-reasoning or restructuring knowledge (the latter of which Segev-Miller refers to as macroproposition or complex meaning making). I also looked for markers of agency in their journaling, following the

⁴² The concepts and concept terms chosen for this measurement tool relate to the core purpose of concept mapping, as theorized and researched by Medvedeva and Recuber. Medvedeva and Recuber cite research by Davies, whom they quote as describing CMAP's purpose to create "detail and visualize relationships between ideas" (140).

outline presented in Table 3: Coding for Agency. As I reviewed these 15 sets of data from student journals, a number of interesting findings emerged related to my second research question's focus on whether active engagement in visual representations of student knowledge building might generate or indicate any transformation of ideas. Specifically, I examined selected journal entries for any indications that students' process choices for deliberate assembly, connection, and association behaviors within their maps might change over the course of the semester, or translate into their later synthesis writing efforts, according to the Master Code Continuum. I also looked for examples of representational reasoning that might suggest that student use of mapping features might carry clues to their cognitive meaning-making behaviors.

Early Concept Map Entry: Construction as Rhetorical vs. Conceptual Process

The earliest and latest journal entries⁴³ ask students to reflect on using concept mapping “to help develop . . . thinking.” The early prompt takes place in the third week of the term, before students start constructing their map and conducting research. The prompt asks students to discuss their thoughts on representational possibilities offered by concept maps, as guided by a definition of synthesis that incorporates the idea of constructing knowledge by recognizing and building *relationships, associations, and patterns*. After an in-class review of materials⁴⁴ on the functions of concept maps and their features (nodes, lines, arrows, labels, and graphic elements like colors and multimodal), students are asked to “write about [their] thoughts on using a concept map to help develop [their] thinking” and “about any features of the concept map that interest [them] in some way.” This followed an in-class discussion of how these affordances are visual means of “representing our logic and reasoning” by literally constructing knowledge by

⁴³ A list of assigned Journal prompts is included in Appendix D.

⁴⁴ See Appendix D for Instructional Materials.

graphically representing relationships, associational discoveries, and structural or conceptual patterns on a visual plane as a meaning-making process (see handout titled “The Functions of Our Map Features” in Appendix D).

This first journal entry provides me with a more detailed picture of students’ pre-existing knowledge about mapping as an inventional practice, especially as a cognitive processing aid, and sets up a touchstone to other journal entries focused on constructive and invention opportunities. In the first mapping-related journal, nearly all students spoke of concept mapping in terms of rhetorical processes: organizing, planning, and writing. Terms like “focus” or “organize” to describe their early perceptions of mapping’s benefits suggest more of an organizational or outlining tool function. Several student writers’ entries for this same journal prompt contained comments that appeared more focused on cognitive processes of invention, which first-pass coding had been marked as Pc (process conceptual) as distinguished from PR (process rhetorical). These students’ journals illustrate the role played by visualization as a means of constructing new knowledge, as well as the *process* of understanding ideas (conceptualizing). These categories and corresponding illustrative samples of student comments are summarized in Table 12 below.

| Category | Codes | Student Response Examples (Emphasis Added) |
|---|--|---|
| Rhetorical Processes | structural or organizing terms; writing process terms | <p>“<i>organizing</i> my thinking”; “how it can help <i>make writing easier</i> and more efficient” (Student 5);</p> <p>“a <i>checklist</i> for my thoughts to help keep my brain’s thoughts on the right track” (Student 10);</p> <p>“help keep us focused and <i>on track</i>” (Student 14)</p> |
| Cognitive Process of Invention: Process Conceptual (Pc) | intentional terms/behaviors related to conceptualizing process: constructing new knowledge & meaning, visible thinking, representation, reflective designing, discovering relationships; mental schema; cognitive offloading | <p>“will help <i>create new ideas</i>” and looked forward to creating a map as a way “<i>to see</i> where my <i>thinking</i> goes” (Student #2);</p> <p>“This <i>process of connecting pieces of knowledge</i> allows us to be able to put information together to <i>better understand it and how it connects</i> ... [U]sing concept maps . . . allows [us] to see a <i>visual</i> of how we are <i>connecting</i> our knowledge to better understand it.” (Student #3);</p> <p>“a map is a <i>form of direction</i> we use maps to <i>help us locate</i> our destination, same with a concept map it is to form <i>direction of our thinking process</i>” (Student #3);</p> <p>helps students “<i>figure out</i> exactly what they want to write about” or to “<i>come up with more ideas</i> to expand on” (Student #9);</p> <p>“using a concept map <i>develops my thoughts</i> better and gets me into <i>deeper thinking</i> about my topic” (Student #11);</p> <p>it is a “struggle . . . to make it all make sense in my head” before “put[ting] it on paper” (Student #8);</p> <p>“you can begin to <i>see</i> how things start connecting to each other . . . <i>seeing everything</i> that you have to work with <i>instead of just trying to pull everything from the top of your head</i>” (Student #4)</p> |

Table 12: First Journal Entry, Coding Student Perceptions of Concept Mapping Experience

| | | |
|---|---|--|
| Cognitive Process of Invention: Process Rhetorical (PR) | terms/behaviors related to rhetorical structures (e.g., thesis structure, outlining, building evidence, argument support) | <p>“I <i>see</i> from where I started with mapping <i>and where I am now</i> I am starting to <i>put things together . . .</i> where I want to <i>go with my argument . . .</i> design choices “help <i>explain</i> my argument” (Student #3);</p> <p>“concept maps . . . allowed me to really <i>recount every detail</i> of the story I was trying to convey” (Student #6)</p> |
|---|---|--|

Table 12: Continued

Students’ journaling comments about their concept mapping summarized a range of generative conceptual and inventional behaviors, including processes of discovery and creation through visualization (*I see*), construction (both rhetorical and conceptual), and new meaning and understanding (assembling and connecting terms, as well as associating and generating, capture the first three levels of the Process Continuum tool of the Master Code List). Student comments often related developing new meaning through patterns (in a process of creating mental schema), as well as the benefit of cognitive offloading (*helping me think; seeing connections*). Such comments appear to illustrate concept map research that draws from constructivist theories of learning, that such schemas as “knowledge structures that humans hold in their minds” (Jonassen et al. 6) function to “inform future thinking or action . . . [and] are fundamental to the way we understand all experience” (Bruillard and Baron 331).

There were some students who expressed reservations about using concept mapping as an integrated part of their writing and research process. Student #7, for example, used terms like “confusing,” or “a hassle when you don’t know how to interpret” a map. Interestingly, this student immediately followed up by writing that these concerns would likely be resolved if “taught how to create or read” a concept map. Indeed, this student would write in one of her final

journal entries that learning with concept mapping actually contributed positively to her writing as well as invention processes, suggesting both rhetorical and conceptual transference took place. She writes that “[a]fter creating my Mindomo Map, I found it very easy to transform my simple word phrases into paragraphs,” suggesting a map-to-text relationship. She also points to both organizational and discovery benefits, as the mapping “help me organized my essays and journals in a neat way, so I won’t have to stress or brainstorm about what to write about. I think this map has helped not only me but my fellow classmates as well. I took the information in my map and transformed it into factual and useful research.” Another student, Student #10, writes that her inability to “explain” her “process of thinking” (marked as Pc for process conceptual) might correlate to her “struggle with” concept mapping, perhaps an allusion to organizational as well as conceptualization behaviors. Her unease with using concept mapping as part of her writing process continues to the end of the term, as she records her final thoughts on her concept mapping design choices that even though she used color and alignment/layout choices to represent content, these were more organizational choices (“I used different colors to help me differentiate my topics”). The student’s superficial approach to the features of her concept map may simply reflect a resistance to the tool itself (“I do not like concept maps”), yet this student’s final research essay seems to demonstrate only Listing and Summary practices, with no evidence of more complex Deconstruction & Reconstruction or Synthesis behaviors. Whether this might suggest a correlation of behaviors is not yet clear.

It might be worthwhile here to note that a nominal coding for behaviors from these journals seems to suggest the possibility of an interesting trend in terms of associations between engagement with design features and cognitive meaning making. As seen in Figure 12 below, there seems to be a potential parallel trend suggested from coding journals for the degree to

which students used the affordances (Design Tools) to represent knowledge (Legend feature “uses design features for representation/does not”) and for indicators of the degree to which students commented on using their maps to aid their writing and thinking.

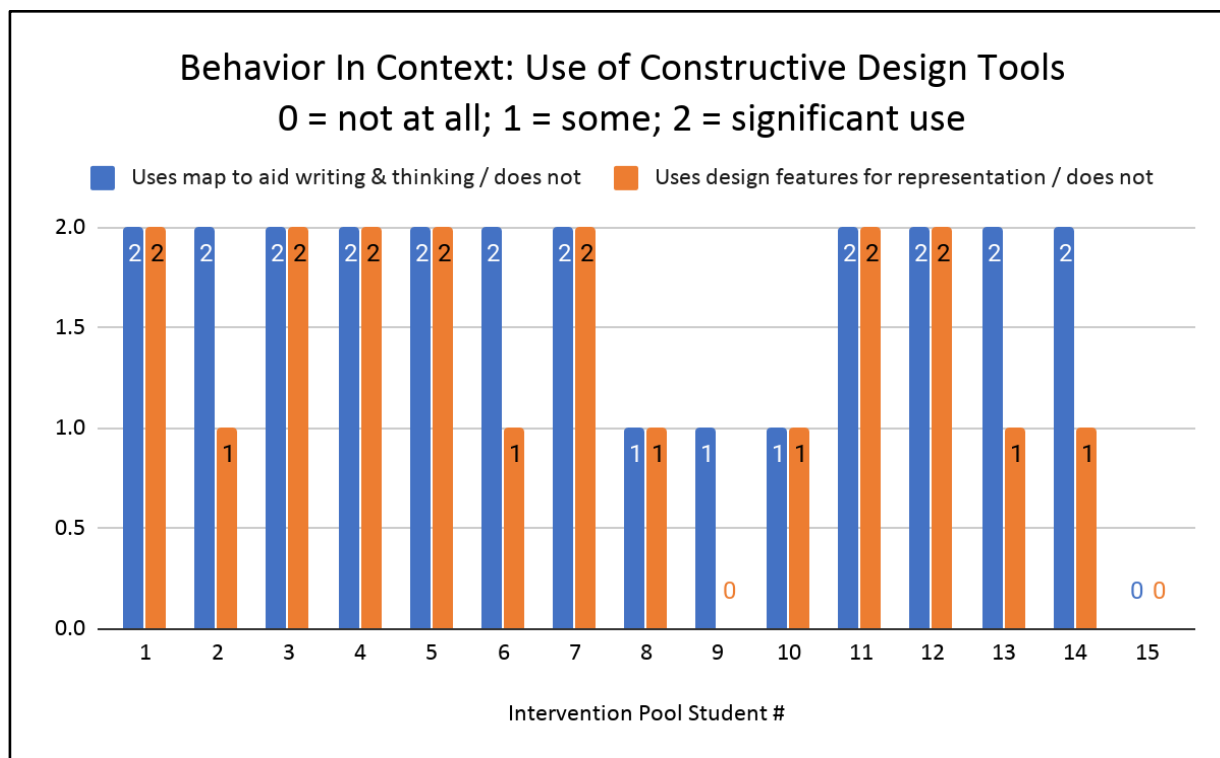


Figure 12: Journal Data Coded for Design Feature Use as Behavior in Context

Out of the 15 student journals examined, over half (10) suggest a pattern of correlation in terms of degree (either 2:2 or 1:1), with students 2, 6, 9, 13, and 14 showing a close variation (2:1 or 1:0). Only one student exhibited no measurable behaviors at all (#15).

When compared to coding for Transfer Behavior/Mirroring seen occurring between students’ final maps and their final essays (illustrated in Figure 13), it is interesting to note that those students who scored 2:2 in data from Figure 12 for behavior in context coding for design use also coded highest (2) in data from Figure 13 to indicate significant mirroring was occurring.

Such mirroring includes content mirroring (linguistic text from connector labels appearing in parallel forms in student essays), as well as conceptual mirroring (visual connections and relationships from mapping/map design choices appearing in comparable meaning-making ways in student text). This will be discussed further in sections below related to Data Groups 3 and 4.

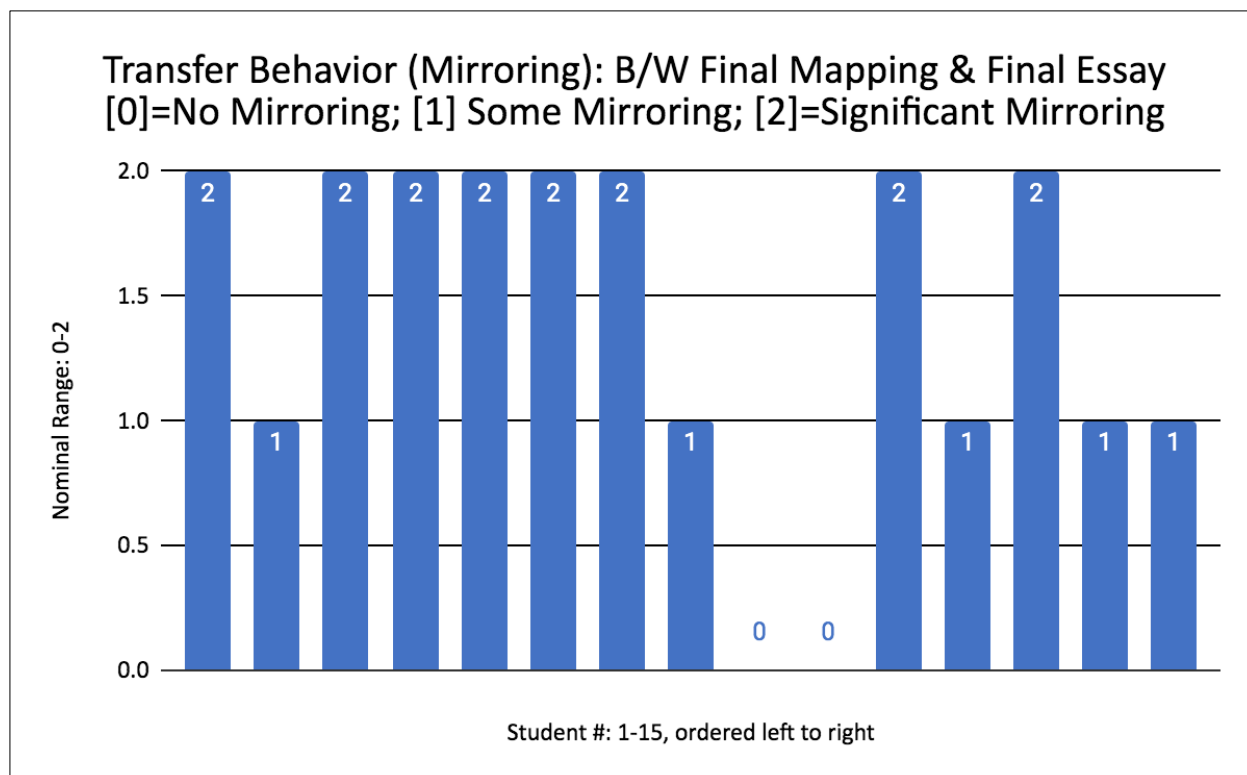


Figure 13: Journal Data Coded for Mirroring Between Mapping and Final Essay, Where 0=Not At All, 1=Some, 2=Significant Mirroring

These results seem to suggest that students who actively used design features of the map to represent concepts or construction efforts in turn demonstrate—through explicit student comments or coded markers of knowledge construction such as KC, KD, or KN—some connection to student writing and invention.

Construction Through Design: Reading Journals for Complex Concept Building Moves

Student journals also contained entries that focused on early student attempts to synthesize sources and were coded for the presence of a range of pre-synthesis moves, as illustrated in the Master Coding Continuum. In particular, I examined a range of passages to determine if there were perceptible transitions from basic Listing and Summarizing (Assembling/Constructing or Connecting/Linking) practices to the more advanced practices that involved more Associating/Generating and Restructuring moves. I also coded these same passages for types of knowledge, specifically looking for examples of combining knowledge (KC) characterized by Listing and Summarizing, developing knowledge (KD) as attempts to construct relationships by Incorporating, all the way to examples of transforming and/or generating new knowledge (KN) practices that display clear efforts to restructure on a conceptual level (D&R). The goal was to see if there were any indicators that the frequency of KD and KN increased the more students engaged in map construction activities, or if the number of KC practices decreased.

Several (6) journal prompts were assigned throughout the semester to practice synthesis thinking/writing strategies as well as drafting essay content. A review of students' first synthesis attempt in journal prewriting seems to suggest that most students at this point relied on largely simplistic KC language of connecting or listing rather than more complex practices toward incorporating or restructuring on a conceptual level.

First Synthesis Writing Sample

In Week 5, students began to construct their early maps during in-class workshop sessions; at this point, these maps only contained supporting premises as nodes connected to their argument's working thesis claim. For this first synthesis journal, students were asked to

construct a response that identified and discussed two assigned articles in terms of how they might be *conceptually* related (the same two articles were provided to all students to ensure consistency for analysis). The prompt began with a common listing exercise to identify similar/different, but then asked students to think conceptually in terms of purpose (argument):

Prompt: “Look for general areas where they are similar or different, not necessarily specific details. Which of the two do you think is more persuasive or makes a stronger point about digital technologies’ influence? Why do you think that?”

Out of the 15 student samples reviewed, only 5 completed this activity (Students 1-3, 12, & 14), making it difficult to use this as a reliable early touchstone for exploring student synthesis practices. However, of those who did complete this first entry, the coding suggests positive examples of conceptual and rhetorical cognitive efforts (see Table 13 below for examples). All entries unsurprisingly demonstrated Listing and Summarizing behaviors as part of their knowledge building efforts, and all but one practiced Incorporating on a conceptual level, with passages predominantly coded for Knowledge Developing (KD) and new knowledge construction, or early/simple D&R (KN).

| Category | Codes | Student Response Examples |
|--|-------|--|
| Combining Knowledge: Assembling by Listing, Summarizing | KC | <p>“What they have in common to me is the use of technology and both are about females” (Student #12)</p> <p>one article “points out the positive . . . while [the other] highlights a more negative view” (Student #14)</p> |
| Developing Knowledge: Connecting or Associating by Incorporating | KD | <p>“I feel that Contrera could have talked more about how we can fix the issue of teens being so impacted . . .”</p> <p>“Even though Davidson talked about how . . . , I feel that it is still a distraction” (Student #1)</p> |

Table 13: First Synthesis Writing Journal Entry Coded for Concept Building Moves

| Category | Codes | Student Response Examples |
|---|-------|--|
| Transforming/Generating New Knowledge: Conceptual Restructuring (D&R) | KN | <p>“She is a part of the generation that is glued to their phones and doesn’t really connect . . .”</p> <p>“what I noticed . . . it seems . . . I believe,”</p> <p>“In today’s generation technology is the biggest problem, because some feel that too much technology affects the mind.”</p> <p>“I . . . feel as if they didn’t dig deep enough to talk about the situation at hand.” (Student #2)</p> <p>“I just feel like the article just kept talking about the personal life of Katherine and her involvement in her phone than instead of an overall problem that it’s causing for teens of this generation. Although [the other] article was more centered on the discourse of using technology as a way of learning things in our society and how it connects us. But when some of that technology is taken away it is like taking a part of our identity in society away since we should be able to see what everyone thinks no matter how farfetched that it may be.” (Student #3)</p> |

Table 13: Continued

As Table 13 shows, only Student #12 was coded using only KC; this was a much shorter writing passage in which the student practiced a more simple Incorporating move by combining source ideas without deeper relational efforts, and relying largely on Listing and Summary. Student #14 is somewhat more engaged, but not quite at the level of conceptualization; the writing sample is more on the level of Assembling/Constructing, with evidence of two simple Connecting efforts limited to functional observations such her comment “points out the positive . . . while [the other] highlights a more negative view.” In contrast, Student #2 not only engages with the two articles individually on a meta-commentary level: “She is a part of the generation . . .” (a conceptualization/discovery move related to Associating/Generating processes), but also creates passages incorporating phrases like “it seems,” “what I noticed,” “I feel that both articles,” and “I

believe” (indicators of conceptualization based on agency-inspired efforts to generate new connections and patterns).

Journal entries for students 1, 2, and 3 all contained passages that were coded as MM (meaning making) and KN (new knowledge) for more complex knowledge construction moves of Transforming/Restructuring and complex comparison of concepts (complex D&R). For example, Student #2—the only student whose passage received the coding of T for Transforming—writes using phrases like “what I noticed,” “it seems,” “I believe,” but also engages in interpretation, following a summary comment on one article with the following meta-connection observation: “In today’s generation . . . because some feel that too much technology affects the mind.” Later in her concluding section, she moves on from Listing/Summary to analysis and critique: “I . . . feel as if they didn’t dig deep enough to talk about the situation at hand.” Similarly, Student #3 also engages in Transforming/Restructuring in passages that illustrate both meta-commentary as well as complex comparison: “I just feel like the article just kept talking about the personal life of Katherine. . . .” This passage, fully represented in Table 13 above, clearly exhibits student agency in her associational attempts, drawing on the student’s understanding of the course theme (identity and technology) as well as the rhetorical purpose of argument (problems for teenagers) to respond to the synthesis prompt.

While limited in number (a sign of the “messiness” of classroom-based studies), these early examples of student synthesis writing attempts provide pre-mapping examples of the types of student knowledge-building practices often seen in synthesis writing: Listing and Summary, along with early Connecting/Linking strategies of Incorporating practices. While admittedly incomplete in terms of providing a broad base of sampling, this first synthesis example does demonstrate the full range of four primary themes emerging as a continuum of progressive

markers of synthesis processes: Assembling/Constructing, Connecting/Linking, Associating/Generating, Transforming/Restructuring.

Synthesis Writing Samples 2: Map Then Write

The next phase of synthesis learning activities focused on writing from their mapping. This part of the study was intended to provide materials that might be examined for any observable traces of movement from Connecting/Linking (KC) to Associating/Generating (KD and meaning making color coding) within their writing, as well as for patterns that could suggest how or whether visualization prewriting might be transferring over to writing behaviors in terms of structural knowledge building (structural-relational-conceptual), especially in terms of Conceptual Transforming or Restructuring (KN). Starting in Week 9, after students had begun to gather source material for their own research support, students participated in in-class mapping workshops to begin populating their maps with sources as new nodes, creating connector lines, arrows, and labels to assemble, construct, and connect based on their discovery process of identifying relationships based on structural (knowing that) and relational (knowing how) traits. These traits included commonalities or contrasts (pro/con), claim types, and rhetorical functions (definitions, supporting examples, proof, etc.). Classroom activities were actively and continuously framed using the metaphor of an exploratory journey of knowledge discovery, where their mapping choices should be “representations of [their] thinking and [their] research, showing how [they] are beginning to envision [their] researched argument as a complex network of *relationships* and intersections among sources . . . leading [them] to new discoveries and conclusions.”⁴⁵ Students were reminded that the map’s affordances of color, images, shapes, lines, and layouts “help [them] begin representing [their] thinking in a visual way, to illuminate

⁴⁵ Full instructions provided to students can be found in Appendix D, titled “Mindomo Concept Map Progress Posts (NP1–NP3.)”

[their] reasoning and connections between [the] thesis idea, [the] sources, and [their] developing research points.”

Students had previously begun using nodes and colors to practice categorizing their early argument’s structure (research question, claim, premises or reasons) as concepts. After reviewing a sample I created to model the process, students followed the prompt in Figure 14 below.

In Your Map: Take a look at your “because” nodes and the source nodes you’ve added. Begin by adding several offshoot nodes to the sources.

NEXT: Connector Lines -- Ask yourself where these 6 (or more) sources might “fit”? Where do you envision they might play a role in supporting your **premise / supporting reason** you created in a node? (Consider whether you might need to add a NEW node for a new or sub-reason.)

Draw one or more connector lines between a source and one or more of your “because” nodes based on your answer. **Carefully consider the direction of the arrow you are creating. What does that direction imply about the relationship between the Premise and the Source?** (you can always change it later)

THINK ABOUT THE RELATIONSHIPS you are creating! Are they based on, reflecting claim, reason, source, function, appeal?

NEXT: Connector Labels
The box on the connector should reflect what type of supporting information or idea you think you can draw from that source that will help you support that point. **Use a verb phrase or noun phrase** that demonstrates HOW & WHAT type of information that source contributes to your reasoning. Use the handout named “Synthesis Terminology” to supply these label terms.

THINK ABOUT THE RELATIONSHIPS you are creating! Are they based on, reflecting claim, reason, source, function, appeal?

Figure 14: Instructional Prompt for Week #9 Map Construction

After this activity, students were asked to write a series of short synthesis passages based on their map work, both as in-class-collaborative and out of class tasks. Over the course of weeks 10-12, students wrote multiple entries that directly used their created map structure to help them construct new synthesis passages from sources their maps identified as related/connected.

Explicit instructions were provided asking students to use the associational potential of their map's structure to help them restructure source knowledge by identifying (visualizing) relationships based on how they had identified the sources' rhetorical function; that is, how they had decided each source would serve a specified rhetorical purpose in their argument, such as addition, contrast, illustration, etc.

During Weeks 11 and 12, students were asked to focus their synthesis efforts in specific rhetorically grounded ways. For both weeks' posts, students were asked to write a new synthesis of sources paragraph based on relationships identified in their map constructions. Students were then introduced to a paragraph-scaffolding model called SIEL (Statement of purpose + Illustrative details + Explanation of details + Link to purpose or next detail).⁴⁶ Because these journals were intentionally designed to be informal writing spaces, submitted paragraphs were not expected to strictly adhere to final-draft conventions. Instead, I was looking for concept building in terms of relational and conceptual structures that might appear as reflective meaning-making phrasing (e.g., *I believe*, *I see*, *this shows*, or *this means*).

In my review of students' results, I found a number of interesting patterns emerging, specifically the degree to which student writing moved from Knowledge Telling (typically coded as Listing, Summarizing, and simple Incorporating) to Knowledge Transforming (more complex conceptual/relational Incorporating, Simple Early D&R, as well as clear transforming as Complex D&R and Synthesis). Of the 15 students sampled, only 6 posted most (4 or 5) of the 5 pre-synthesis paragraphs; 4 students posted only 2 or 3; and 5 students posted 1 or none. While

⁴⁶ The SIEL (aka SEIL) model was first created by an AUM colleague, Dr. Robert Evans, and has been widely adopted in our writing program as a scaffolding instructional tool designed to help students consider the rhetorical structure of paragraphs. It has been quite successful in helping students move away from other paragraph-building heuristics rooted in producing a minimum number of sentences. It is illustrated in detail in Stephen Bray's article "The SIEL Method."

lack of data is still data, with such a small data pool it would be difficult to trace change or development over time without most of the pre-synthesis entries attempted, so I focused on the 6 students who posted 4 or more entries.

To look for traces of any developmental trends, I began by focusing on the written passages from Students 1-3 and 12 (all of whom completed the pre-synthesis activity of Journal #4 previously described), alongside the coding results of their mapping activities (see Measurement Tool 3 previously described). Table 14 below illustrates the coding strategies and definitions used to capture evolving student synthesis behaviors according to the continuum of the Master Code List.

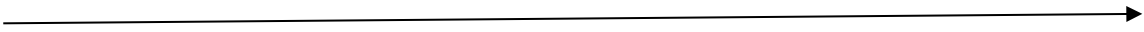
| KC | KD | KC + KD + <i>early</i> KN | KN |
|---|---------------------------------------|--|--|
| Assembling/Constructing (Summary, Listing) | Connecting/Linking (Incorporating) | Associating/Generating (Incorporating, Early D&R) | Transforming/Restructuring (Complex D&R, Synthesis) |
| <i>Knowledge Telling</i> | | <i>Knowledge Transforming</i> | |
| Continuum  | | | |

Table 14: Evolving Student Synthesis Structural Behaviors Post-Maps

Students 1 and 3 demonstrated evolution from simple Assembly/Constructing (Listing, Summarizing) and limited/no Connecting/Linking (Incorporating) to more obvious but early Generating (simple Incorporating), and (in the case of Student 3) more complex processes of Restructuring. For example, in their Week 10 paragraphs both Student 1 and 3 followed a Listing structure that appears to be at the Assembly/ Constructing stage of concept building; a final comment by Student #1 seems to be an attempt at simple Generating: “These two articles

argue...but in different aspects. One argues . . . where the other argues For my argument, this means” This pattern closely adheres to the assignment prompt asking them to focus on the *relationship* the student wants to create between the two sources (a rhetorical, agency-based connective function of Incorporating as a knowledge building practice). The same student’s later synthesis attempts from Week 12, following substantial reflective work on their mapping connections and representation, seems to demonstrate a degree of more complex Incorporating in early/simple meaning-making discussion: “it allows me to see that digital media can be a pro in certain situations, as well as it has the ability to boost a child’s imagination” (Student #1). In another passage, this same student writes that “this source shows me how digital media can help children and their future, instead of it always having a negative impact on them.” Coding indicated for this student’s visual design does indicate that her labels contained largely functional relational language (*examples, impact*), with some rhetorical/relational terms (*illustrates, cause/effect*), with simple connector line use (no arrows, only uni-directional lines rather than multi-point connections).

Student #3 provides even more complex examples of evolution, in both her visual design (complex structures) and her synthesis passages. Coding reveals that both her design and writing choices demonstrate the entire range of processes, from Assembling all the way to Restructuring, and contains more relational vocabulary: *connect, this means, both agree . . . but in different ways, I’m trying to show*. Figure 15 below is a snapshot of one section of Student #3’s map that demonstrates complex construction.

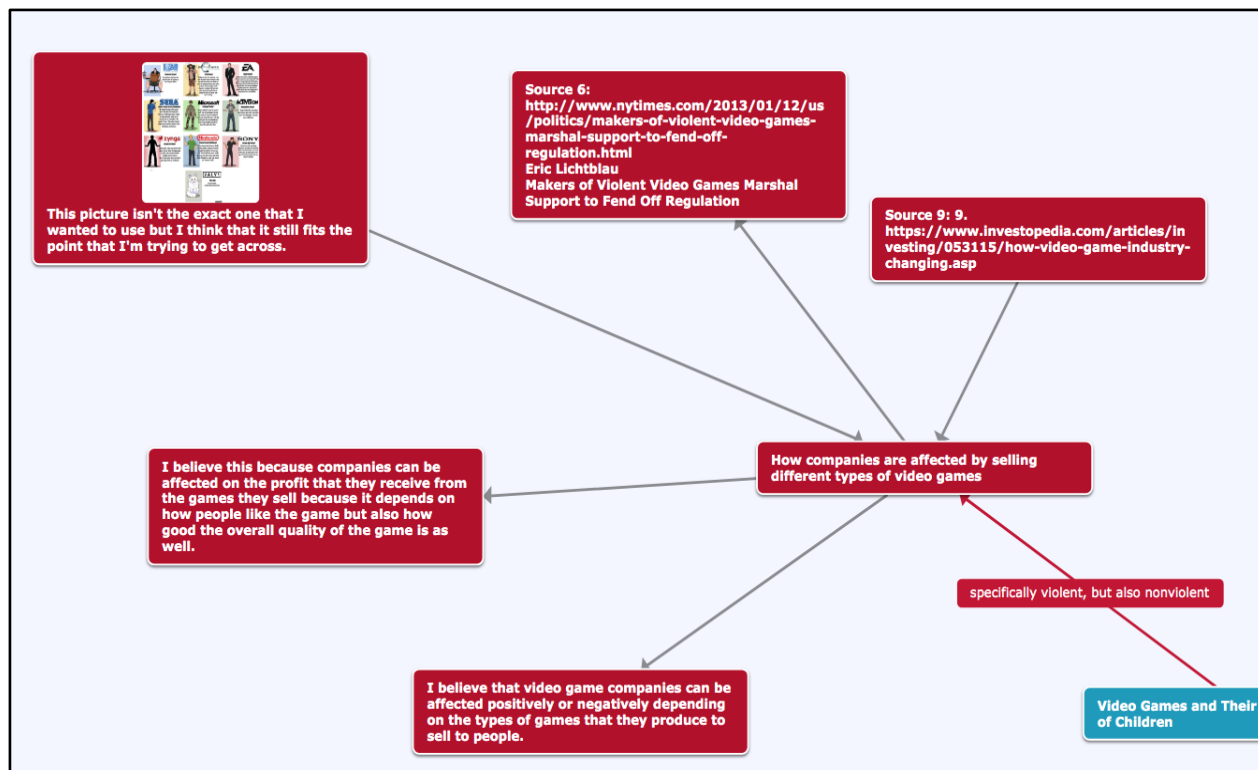


Figure 15: Student #3 Map Section Demonstrating Complex Construction Choices⁴⁷

This student also pointedly refers to her map construction as a guide to her writing: “According to my labels that I used in my map, I connected them by saying that they both had examples from students to show that they agree that violent video games can affect the minds of adolescents. Plus, they also seem to connect by showing that depending on the types of games that adolescents play can affect their minds.” The student’s map demonstrates the visualization of these labels’ functional roles, as seen in Figure 16 below. (I have added embedded text boxes to the image to clarify smaller print generated by the map.)

⁴⁷ Images of student maps throughout this document are taken directly from students’ Mindomo creations. The small font size in these images is the software’s default setting and not always clearly legible once downloaded from the Mindomo site. The maps themselves, as reproduced for this document, are meant to be visual illustrations of students’ construction efforts. All significant text content is discussed in the body of this work.

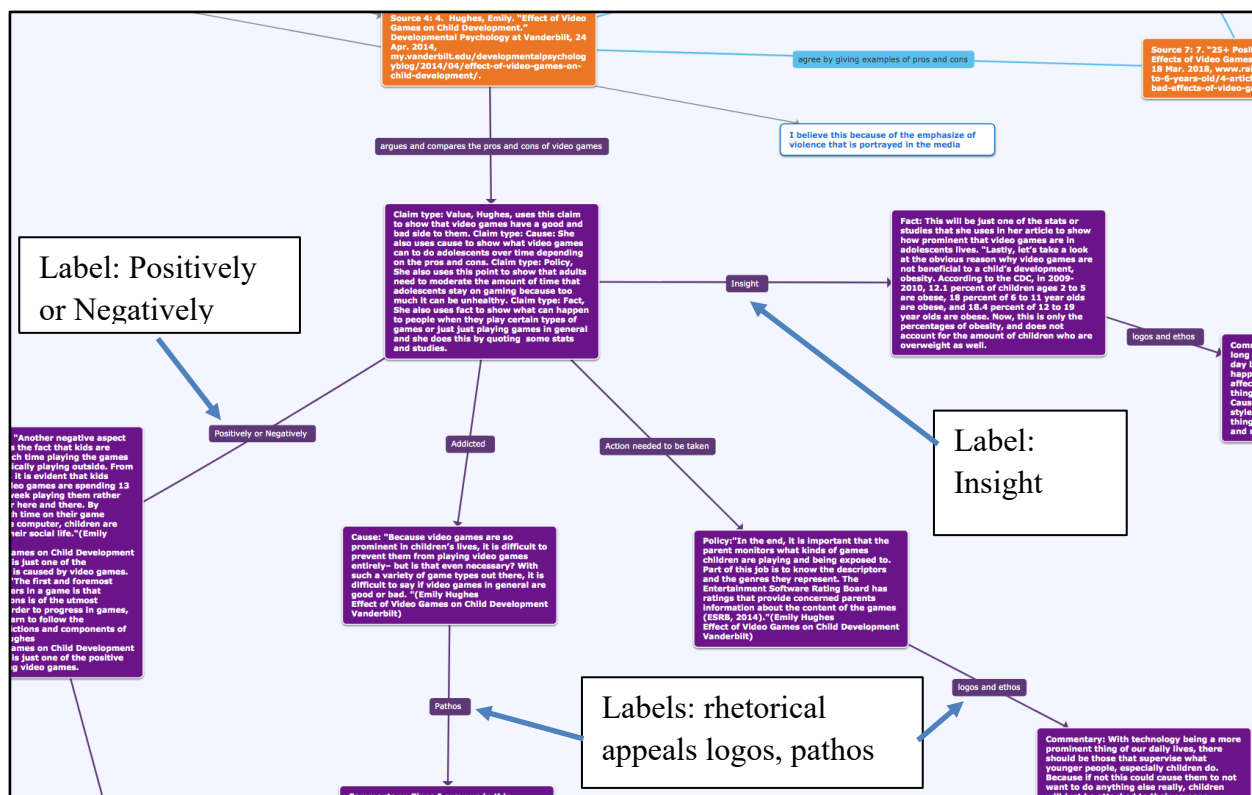


Figure 16: Student #3 Map Section Demonstrates Visualization of Label Use in Functional Terms

By Week 12, Student 3 exhibited more examples of Conceptual Incorporating (Associating/Generating) than Listing (Assembling), with a clear effort to position her use of sources for rhetorical and conceptual Transforming purpose: “I believe that . . . some of these violent games lead to aggression. Two of my sources seem to point this out rather well.” The student then proceeds to use relational as well as rhetorically functional label language like “argue” and “agree with this to a certain extent . . . but” to demonstrate Associating levels of Incorporating and D&R. Following this demonstration of relational and rhetorical concept construction, the writer concludes with a passage coded as Meaning Making and Transforming, complex D&R: “My take from what they show is that violence in gaming is bad since it can be [student paraphrases combined ideas of two sources here] . . . This in the end ties to my argument because depending on the type of games that adolescents play and how they view the

game and perceive it can cause them to look at things they shouldn't which can change them [an effect] in the end, meaning their personality.” This final sentence appears to demonstrate early signs of *knowing why* at the Relational to Conceptual stage of Structural Knowledge building, suggesting the student has moved further down into the Concept Building process continuum to simple Generating and Transforming by associating her own ideas with those of the sources by deconstructing one of their shared main points and reconstructing it to serve her own point about a specific identity effect.

Student #2 demonstrates more simplistic synthesis, limited to only the first two stages of the process continuum (Assembling or Connecting). Her design choices are coded only at the simple structural level, demonstrating largely Assembling/Linking processes, with no real demonstration of Generating-level processes. Figure 17 below represents a sample of Student #2's earliest and most simple, mostly unidirectional connections.

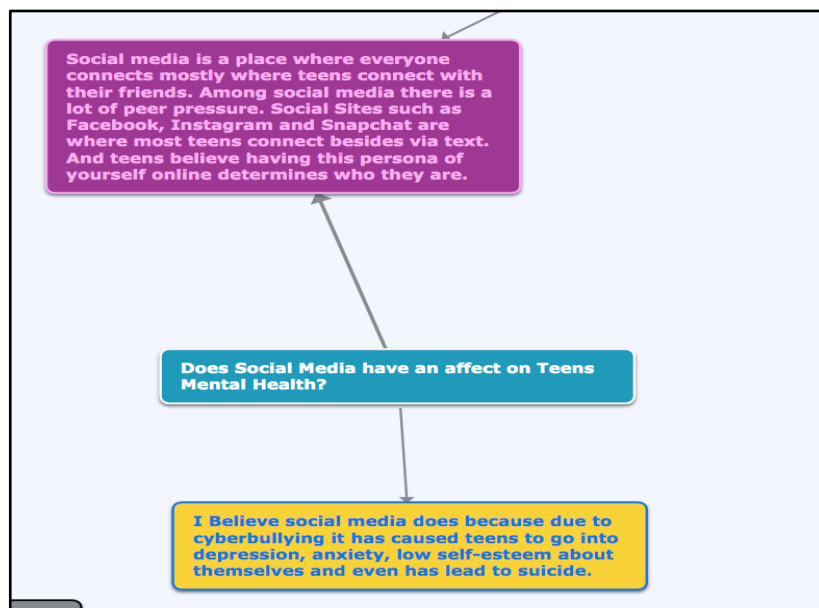


Figure 17: Student #2 Sample of Early Map Section Illustrating Simple, Unidirectional Connections

Student #2's Week 10 entries are largely coded for Listing and simple functional Connecting ("both speak upon . . . both focus on"), and largely consists of Knowledge Telling by simply listing similarities and differences but no explicit transformation leading to New or Developing Knowledge (KN or KD). The Week 12 entry continues at the process continuum levels of Assembling and basic Linking (Listing, Summarizing, simple Incorporating) in both relational and conceptual terms. For example, Student #2 writes a counterargument synthesis paragraph using only one source (Students 1 and 3 incorporated two sources in the same entry), and relies on simple relational and functional phrasing such as agrees, goes against my argument, giving some positive effects. The student does make simple meaning-making efforts, but these are also very simple assembly-level moves: "This source helps me see the positivity media can have instead of just negativity"; "this source . . . helps in way of giving some positive effects that media can have, but still goes against my argument."

Student #12 demonstrates a similar pattern between visual mapping choices coding into early Generating along the continuum. The visualization map coding—which is based on the finished map—does seem to parallel the development seen in her progressive synthesis passages, which move from largely Assembling and Linking in her Week 10 entry into early/simple Generating by Week 12. For example, in her Week 12 entry, this student uses both functional and discovery language to define the relationships between her sources and her meaning making. After summarizing one of her sources' stance, she not only writes that it "sets up a resistance to my argument" (a rhetorical function of counterargument), she continues on to offer a deeper look at her reasoning in a type of Early D&R (Generating): "because one's leadership skills are the first thing scrutinized when considering a position of office. How can you lead individuals into voting for a cause that can be hurtful or harmful to their community?" She then continues into

complex Incorporating at the Associating/Generating level when she writes immediately after: “They [the writers] go on to say that the ‘normal’ gender gap has been established. **To me that is a big contradiction**” (emphasis added). Thus, this students’ Incorporation moves back and forth between selective Summarizing and Early D&R that evidently leads to new knowledge (KN) as well as some degree of Transforming Knowledge (a sign of the final level of the Process Continuum). Coding for this student’s map suggests complex use of map affordances (colors, nodes, connector lines) for Listing and Incorporating, along with Linking and some early/simple levels of Associating/Generating happening in node content as text-based relational information. This type of trending will be further examined in connection with students’ full drafts/final essays and maps, alongside their map narrations discussed in Data Sets 3 and 4.

Coding the Visual: Data Set 3, Examining Premapping Journals & Map Space for Knowledge Design Moves

Every three weeks, beginning in Week 6, students were asked to record one voice-over reflective narration on their mapping process, following specific guided instructions for a total of 3 journal assignments. (The journal directions are found in Appendix D.) The posts followed in-class guided freewriting activities to allow more time for focused reflection. These narrated journal writings (NP 1-3) were designed to promote student reflection on the “why” of their mapping choices in terms of their intended representational and construction efforts (knowledge designing). The first prompt (week 6, post #1) began by asking students for a simple description of their map design as they assembled a basic map of nodes and connector lines for their early topic exploration and preliminary research findings: research question + I believe statement + reasons/because statements as nodes + 3 “discoveries” of sources as yet unconnected to the students’ knowledge structure. This first narration was intentionally simplified in terms of

content and goals to allow students to become accustomed to this form of reflective journal technology. In week 9, after 3 weeks of map construction and research writing activities, students were next asked to “create and explain your cross-connections in your map,” including explanations of why they created those specific node connections and their vocabulary used as labels for connector boxes as representations of the “relationship between the nodes and what that has to do with designing the support of your thinking & argument.” Students completed this narrated entry prior to writing their first small-scaled synthesis paragraph in an effort to get them to explicitly consider their own cognitive processes involved in their knowledge building. By asking them to reflect on the reasoning behind their visual “knowledge designer” efforts, I hoped to promote inventional acts of discovery as well as concept building. By Week 12, students were well into developing and refining their argument’s structure (Claim + Reasoning + Incorporating Support). Therefore, the final reflective narration prompt asked students to choose one part of their map that represents what they felt successfully developed one of their main ideas (premise + support). I then asked them to discuss “how *the act* of mapping” this section “shows the development of your thinking about this main supporting point, . . . and how your thinking, connections, understanding have *changed* from *early* map/early thinking to *current* map/current thinking,” whether productively or not.

Finally, as an opportunity to supplement their video narrations with text-only reflections, I assigned two reflective journals in the final weeks of the course to correspond with finalizing their researched argument essays and their maps. These two journal prompts asked students to reflect on (1) their use of design affordances to demonstrate specific functions and goals, along with their explanation of “why” (this was an in-class writing exercise), and (2) their entire mapping history (using the map’s Playback feature) as a “complex, dense roadmap of where

you've been, where you journeyed, and how far you've come to get to your final developed argument." Students were asked to watch the Playback twice, and then write a 250-word reflection on how their early, middle, and final representational efforts made a difference to their cognitive processes ("your thinking").

After student narration entries were transcribed and coded, I found that 8 of the 15 students had completed at least 2 of the 3 entries (some of which were submitted without audio, however, due to technical issues); only half of those 8 students had completed all 3 entries. All of those students who completed only 2 posts skipped NP1 and began their entries with NP2. (This could be an indication of the impact of a new technology introduced to students' writing process.) Another 7 students completed fewer than 2 posts; 3 of those submitted no posts at all, yet all 15 students did submit a final map.

Trending Patterns Along the Master Code Continuum

Results were examined for any patterns that might suggest a progression of representation or design behaviors using map affordances could correlate to students' progressive efforts to translate these into their cognitive processing and conceptualizing (pattern building).

NP1: Early Overview

As the first prompt merely asks students to "talk through" their early nodal elements and connection choices, it is not surprising to find that most entries from the first narrated premapping entries (designated for brevity's sake as NP1) predominantly contain examples of Assembling/Constructing (listing and other structural comments), falling into the continuum's earliest Knowledge Transforming Stages column of "Knowing That." As well, most of these first entries also demonstrated early Connecting/Linking for Incorporating (discovery and functional incorporating are both observed, with some relational incorporating appearing in a few entries).

This Connecting behavior was largely limited to drawing connector lines between students' knowledge representations (Kp) from nodes for "I Believe" to "Because." These early relational elements were often narrated in terms of addition, movement, and planning: "*And then* I think that..." or "*From there* I will be transitioning into why I believe this."

Student narrations also pointed to their discovery as well as meaning-making goals. Student #10 explicitly makes a connection between design as a representation of such thinking: "And in the purple block, you can see that I have asked four main questions on four topics. And in the gray blocks *that lead to* the purpose blocks you can *really see my thinking about this.*" Such language also provides an Agency cue as the student narratively demonstrates how her cognitive processes are represented (made visible) through her design and structural choices. She also included comments on making early connections between her design process and structural-to-relational reasoning: "My topic is . . . So that's a little broad [a rhetorical/conceptual observation] so I went ahead and *broke it down into . . .*" This suggests the student's design choices reflected her rhetorical motivations in terms of the structural function of her early organizational contents, a cue of Agency. In another Agency illustration, this student also explained how the visualization function of the map relates to her reasoning or conceptual processes: ". . . the gray blocks . . . lead to the purpose blocks [where] you can really *see my thinking about this.* And I was thinking about this because . . . And *what got me thinking . . .*" (It may be worth noting that this student continued to work in the concept map space, but posted no additional narrated entries.)

Interestingly, a few students' NP1 entries showed signs that may anticipate the third stage of the Continuum, Associating/Generating, containing relational and conceptual phrasing such as: "I figured out . . . I'm thinking . . . Once I figured that out, I think it will be easier for me to

understand . . . ” (Student #6). Others like Student #5 relied more on structural phrasing, anticipating Generating as Incorporating future organizational pattern building using design representations: “. . . and I have a pro and a con side to this [cursor moves over these areas as she talks] . . . so that’s why I have it split up: cons are on the right, pros are on the left, and then I kind of have a mixture of both where I really believe is on the bottom . . . ” This same student also forecasts future organizational planning, mixed with comments of a rhetorical planning nature that is more structural in terms of *Knowing How* of the Knowledge Transforming Stages: “. . . and that’s what I think . . . and I have a source for that, also for my con argument [cursor moves over these areas as she talks]. And for my main . . . point of view argument I have a source . . . a few sources on the side that I’m just kind of looking at. I haven’t really decided whether I’m going to use them or not. They have useful information but . . . I don’t want to use too many sources because then . . . maybe some things don’t line up so I don’t want to use too much information for my paper” (Student #5). This seems to be an exhibit of the student’s cognitive processing habits, connecting thinking to anticipated writing, especially when she observes, “The rest of these other bubbles are questions that I’ll be covering throughout my paper. I’m thinking it will be like the body paragraphs.”

NP2: The Why of Design

Entry NP2 (Narrated Post 2) asked students to focus their posts on the “why” of their connections and discuss this in terms of their design choices as representations of their conceptualization efforts. These were coded in terms of Incorporating as an act of meaning making by Associating (Discovery and Relational) as well as Generating new knowledge (simple D&R). The majority of these entries (9 of 15) appear to demonstrate active and cumulative building, often incorporating the first layer of the Process Continuum (Assembling/Constructing)

with Connecting/Linking; at times some students extended this into early Associating/Generating behaviors. Most commonly, entries focused on Incorporating as Discovery (e.g., Student #13: “I do have some questions *that arose from* this topic *To answer these questions* I would say that I believe that”) and Relational (using terms like “illustrates” or “comparison”). Many students used phrases like “I see” in these responses, which by itself may simply be an informal speech mannerism. However, some (like Student #3) explicitly use this phrase to indicate an act of discovery rather than observation: “I want *to see how*.”

A number of students’ entries employed design features to represent developing Associating/Generating processes. Connector Label content was distinguished as either Functional (example, topic, thesis, source type, argues) or Conceptual (expansion, rhetorical appeals, contradicts, compliments, illustrates, questions). This mirrors the Incorporating language used in the Continuum stage of Connecting/Linking, and into the stage of Associating/Generating, to suggest potential for development. The majority (11 of 15) of students used labels in their maps. Among those 11 students who did use the label box feature of the map, 9 frequently used phrasing that was at the Associating/Generating stage of Incorporating (Conceptual, rather than Functional). For example, Student #7 used rhetorical vocabulary drawn from activity handouts to connect her Reasoning nodes to Source nodes, commenting on what her nodes “illustrate” by using labels of rhetorical or conceptual function like claim types: “I go to Illustrates Cause [indicating her label design choice] which is one of my five sources From there I go to my author’s argument that I am trying to reference to, which is the Claim of Cause [another label].” The image capture in Figure 18 illustrates this. (I have embedded text boxes to enlarge and draw attention to certain features.)

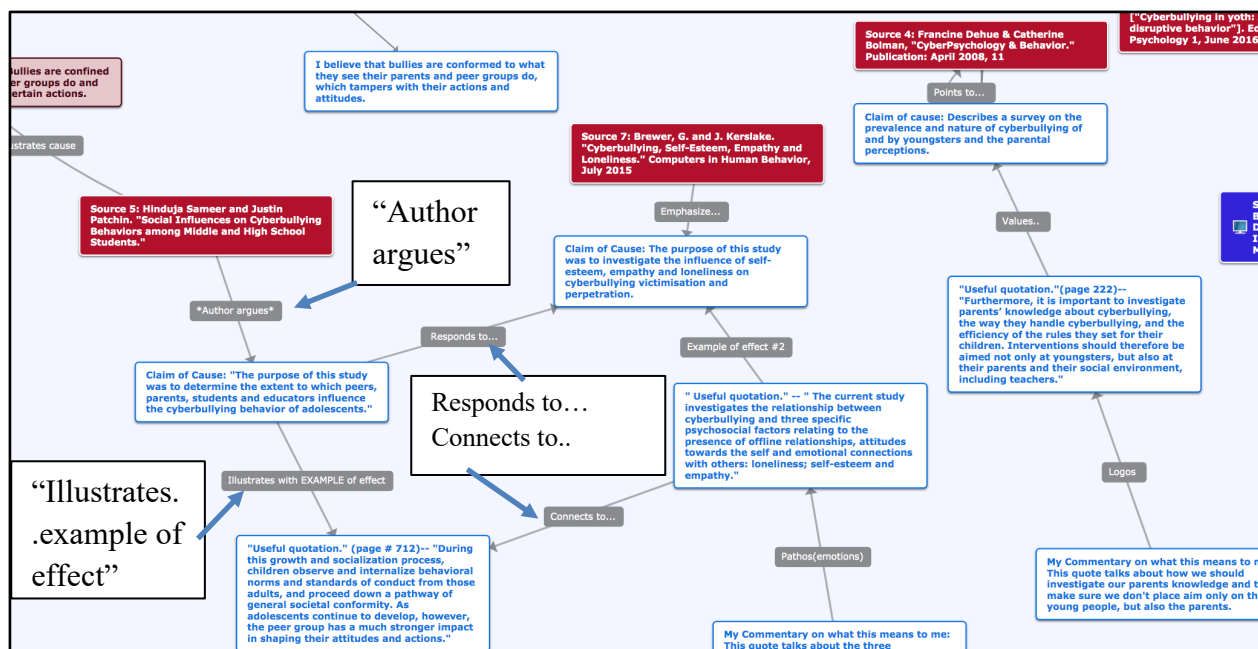


Figure 18: Student #7 Map Image with Rhetorical Labeling

In this case, Student #7 exhibits a conscious constructive design effort to demonstrate a move from Structural (“from there I go”) to Relational building (“cause”). One student (Student #10) used questions instead of phrases in her label boxes. Another (Student #4) used conceptual commentary and associational reasoning (“something that is seen as innocent” and “cultural similarities”) as her label connections. These suggest the student’s understanding of not only the source itself but how she has interpreted its content in terms of her own emerging mental schema of her argument. Student #4’s map is represented in Figure 19 below.

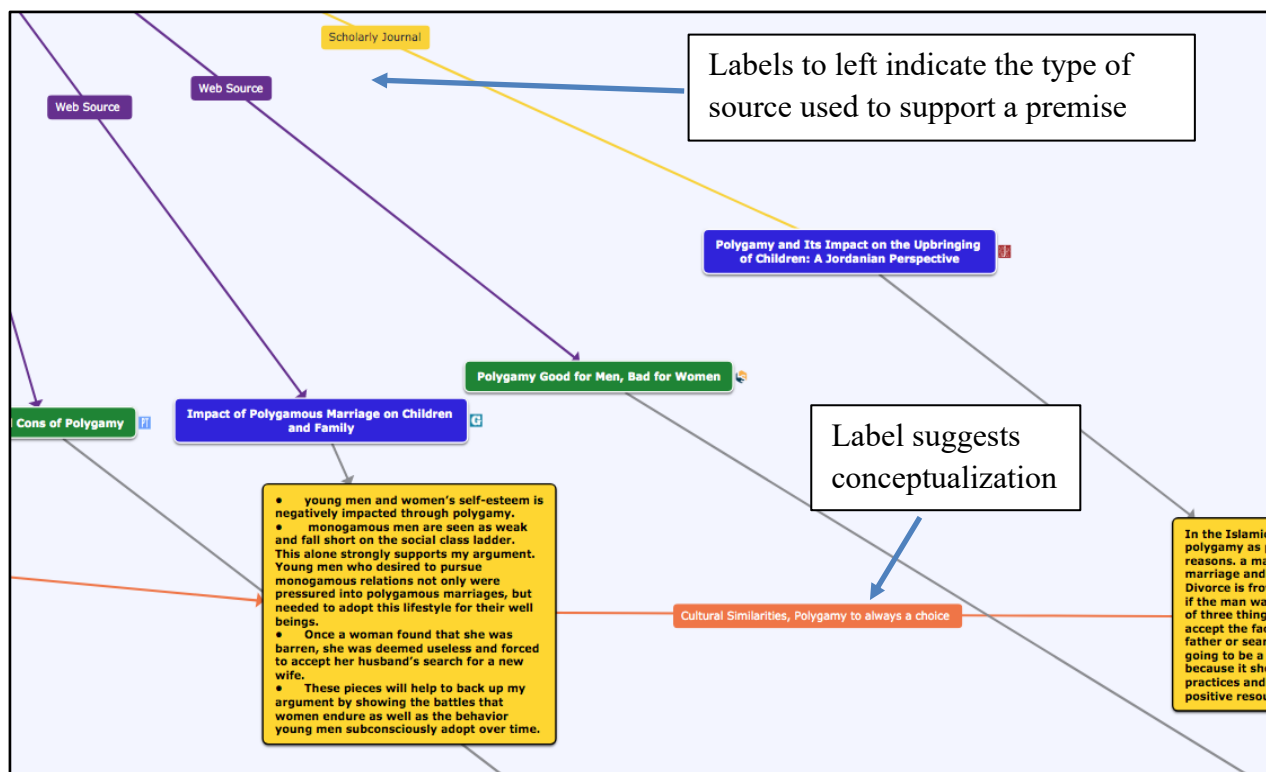


Figure 19: Student #4 Map Selection with Conceptual Commentary Labels

Another example of design choice is the use of arrow connector lines. While the DCMAP program by default creates an arrow connector to represent node relationships, Students 5, 8, and 13 applied these in interesting ways, creating recursive or densely associational patterns rather than simple, unidirectional, mono-connections (only connecting one set of nodes). The image in Figure 20 below is taken from the map by Student #13. While the image itself is too small in this format to read the text in each node, the Figure does capture the complex constructive efforts being made by the student with the help of the map's affordances (connecting lines, font size, arrow directions).

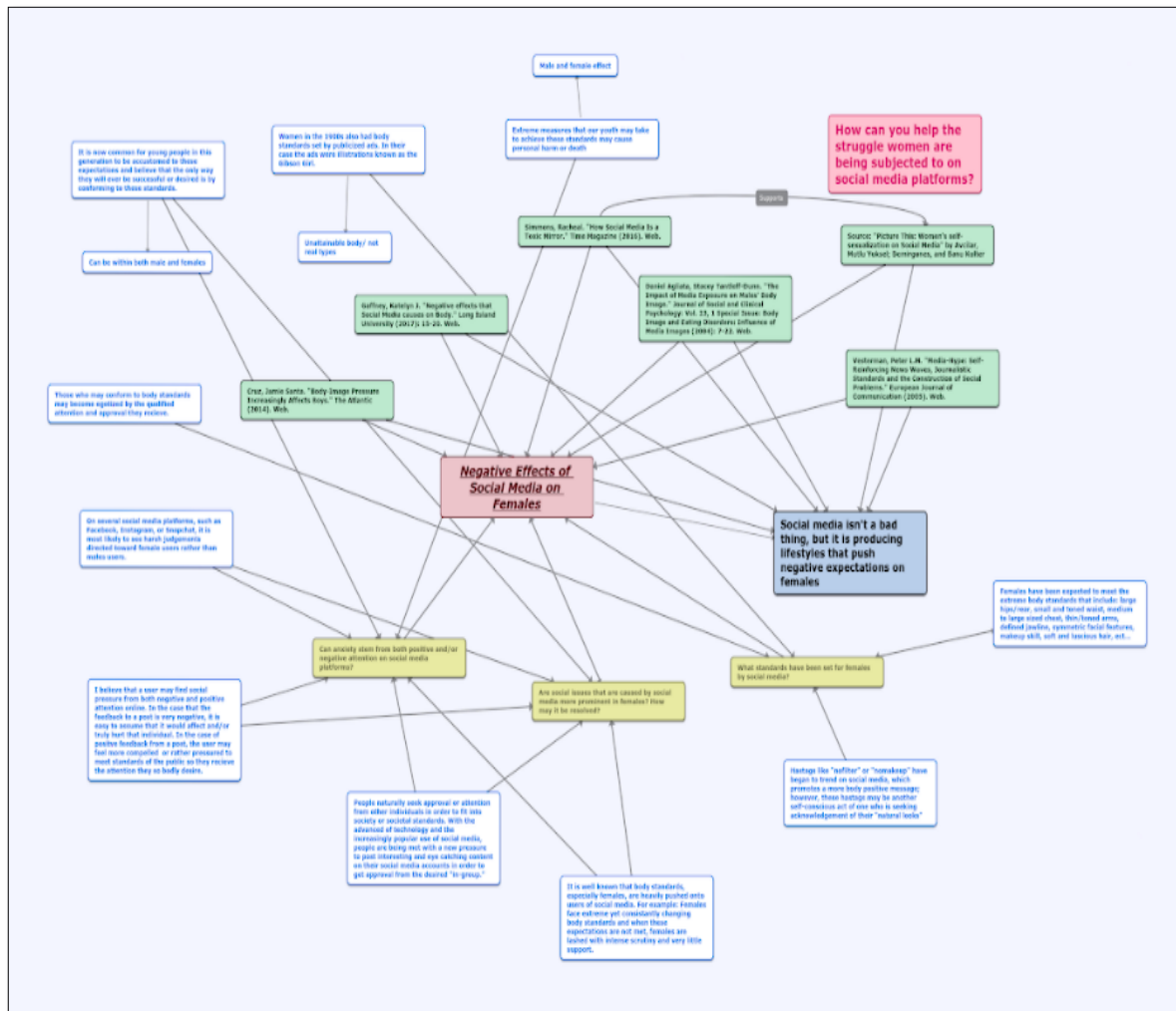


Figure 20: Student #13 Map Illustrates Generative Associational Design Choices

Note the densely packed associational arrow use, many generating multiple relations between student’s concept nodes (I believe statements and questions) and sources, as well as from concept node to concept node. Such representations suggest Incorporation is happening at both a structural/relational as well as conceptual level, an observation reinforced by the student’s narration, which incorporates extensions of ideas not yet explicit in the map. Yet these comments are still tied together in her narration with both functional and relational Incorporating phrases and design choices, as summarized in Table 15 below.

| | |
|---|---|
| <ul style="list-style-type: none"> • Organization of nodes by question and theme | Nodes colored blue, pink=concepts/themes; nodes colored gold-questions |
| <ul style="list-style-type: none"> • “questions that arose” • “to answer these questions” | Signaling invention/discovery |
| <ul style="list-style-type: none"> • “a possible resolution” | Associating/Generating, discovery |
| <ul style="list-style-type: none"> • “that connects to the third source as well as the first and can extend from both positive and negative extension” • “that one actually goes back to the second question” | Assembling/Constructing, Connecting/Linking, & Associating/Generating on all levels of Incorporating: Discovery, Functional, Relational, & Conceptual |

Table 15: Student #13 Narration Reflects on Map Connections Using Functional Plus Relational Incorporation Phrases

In addition to continued Assembling/Constructing moves, student narrations at this point often allude to their conceptual and meaning-making efforts as goals (often juxtaposed to planning terminology), and contained a greater number of passages coded as MM or examples of meaning making behaviors. Of the six students who completed this second entry, all wrote passages containing clear indicators of MM. These passages often contained phrases like: *I think, this means, I see*, or other similar Associating/Generating - Incorporating moves (conceptual/discovery). For example, Student #2 provides a relational comment that associates her own personal experiences with ideas expressed in one of her sources. The recounting of her experience uses language that aligns with the language of the source but modified enough to suggest she is creating a new pathway (a sign of early D&R). She reports that the source points to risks “of social media amongst adolescents” include “cyberbullying, suicide, self-injury, depression, and anxiety”; she then relates this to ideas drawn from other articles from her research, which also point to effects of “depression and anxiety.” The early D&R knowledge building occurs when the student proceeds to *extend* this list of effects by associating it with her own pre-existing knowledge (Kp), writing, “My reasoning for this is I believe social media can

be detrimental and addictive because me, I was born in the new generation. . . . And I can admit that it is addictive.” Student #3 talks through the complex connections afforded by the map design features as the means she used to practice meaning-making on a more Discovery-Relational Incorporating level of Associating/Generating. The following passage from her entry suggests a transition from Connecting/Linking toward early Associating/Generating. This seems to emerge as a direct result of her design choices rather than conceptual Reconstruction (D&R), as suggested by her continued use of such phrasing as “connect, compare, from there I talked about.” Her descriptions of her label connector choices in terms of Incorporating conceptually, using “pathos, logos, ethos,” identify the nature of the functional/rhetorical relationship of her conceptualization efforts as directed by the connection choices within her map.

In another passage, Student #3 exhibits what appears to be an early D&R practice (see Figure 21), a conceptualization move in which she describes the design choices she used to map out the connections between a source and her own pre-existing knowledge/experience (Kp): “For the next one for Cause [a term embedded within the node containing a quote and color coordinated, a choice demonstrating an Associational/Generating move that is relational as well as conceptual associations] I said “addictive” [reference to the connector label] which basically a quote that I took from an article of Hughes, [which] was basically saying [as she interprets by paraphrasing a summary] that people from this current generation, *I myself included*. . . .” The explicit move to narrate the display of connections (as seen in the following image) to include her own views embedded in a separate node labeled as “Commentary” suggests her Associating/Generating process of concept building is influenced by the student’s active mapping of this process.

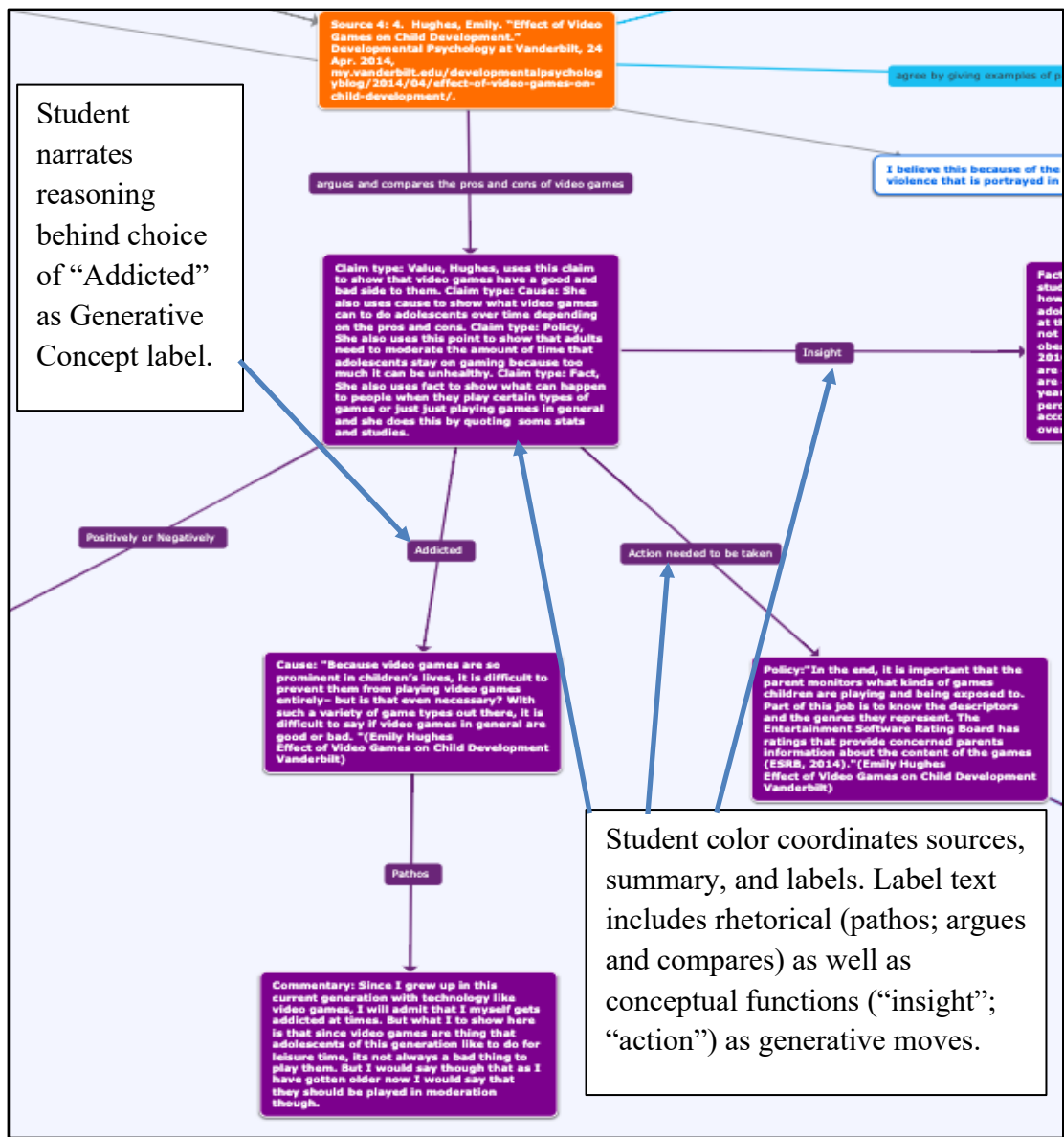


Figure 21: Student #3 Map Exhibiting Early Decomposing & Recomposing (D&R) in Mapping Practice

Student #6 provides another example of meaning-making but used as a planning or goal-oriented move, which seems to be a possible bridging move from complex Connecting-Incorporating as Functional/Relational toward early Generating-Incorporating as Discovery/Relational. Student #6 remarks that she “added more questions” to her map as stand-alone (i.e., unconnected) nodes that she felt she “need[ed] to answer in order for my paper to be

successful.” She appears to clarify what she means by “successful” in the next comment, as she explains a change that has occurred in her map as a result of ongoing research. She recounts a change in approach to her topic, one that takes a more arguable edge, that drives her decision to map new questions as part of her reasoning and efforts to make meaning, an Incorporating move that seems more in line with Associating/Generating than mere Connecting.

NP3: The Agency of Mapping Thinking

The third narrated premapping entry (NP3) moved from asking students to explain the *why* of their design choices to explicitly extrapolate (itself an act of conceptualization) the influence those designing actions had on their thinking (cognitive processing as well as conceptual transforming). The journal prompt asks students to discuss “**how** the **act** of mapping . . . **shows** the **development** of your thinking,” including “connections” and “understanding.” Along with discussions of design choices, the students often used terms of visualization to suggest causation. This frequently occurred in an act I coded as meta-reasoning, or meaning making, in terms of knowing the *why* of their connective motives, grounds for complex conceptual transformation (see the Knowledge Transforming Stages column of the Master Code List Continuum). For example, Student 3 used phrases like “I developed it to show,” or “I was able to see,” and “When I connected them they were able to show me . . . to give me a new perspective.” Another student (Student #8) remarks that the affordances of the DCMAP “came in handy with the part where I had connected my thoughts to each of the sources. *This gave me an idea of what I wanted to talk about and argue for each source.*” This observation suggests the possible connection between the *act* of designing and *seeing* connections is a cognitively productive one, leading to Generating as both a Discovery as well as Conceptual building practice. However, this same student focused most of her comments on structural choices at the

Assembling/Constructing and Connecting/Linking levels of building. Student #8 refers to its organizational function rather than intentional: “While writing my outline of stage 3, I found that once I covered everything that I had on my Mindomo map, I was then at a loss of where to go from there.” As evidenced by the image of this student’s final map (Figure 22 below), the map is structured much like a linear outline, but with most of her sources (green nodes) separated from her conceptual structures of her building argument. (Blue nodes are her research invention questions, and red nodes are her premises. Purple nodes contain only summaries of two isolated numbered sources, the one design choice that demonstrates evidence of efforts to make connections.) A comparison of Student #8’s first map (NP1) varies very little from her third and final map (NP3), with the exception that a few additional source nodes were added to the string at the top (also disconnected from her reasoning), further suggesting the limited continuum progression.

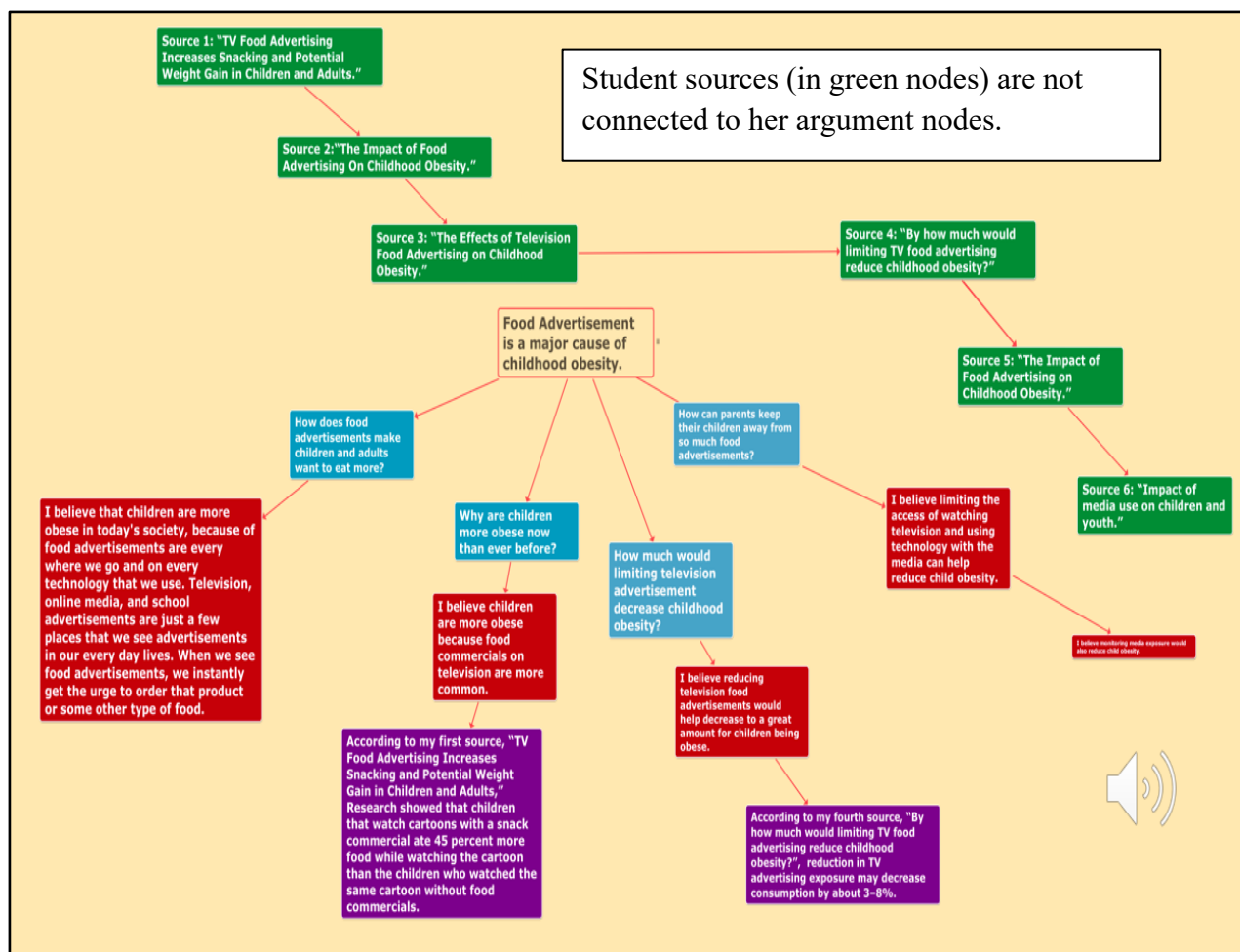


Figure 22: Excerpt from Student #8 Final Map Illustrating Limited and Linear Structural Behaviors

Including Student #8, only two students relied largely on structural phrasing to indicate ways their knowledge building processes have evolved, constructing a rhetorically function-based system of support (comments about adding proof, doing research) rather than from any visualized cognitive association. For example, Student #11 asserts that the “act of mapping this part of the map *shows* not too much of the development of my thinking [but] . . . it does *show the way*” her reasoning connects in a cause-effect pattern of support from source materials (emphasis added). Given this student did not contribute NP1 or NP2, it is possible this is her first attempt to practice conceptualizing ways a mapping process might represent her knowledge building

practices as they evolved over time. Instead, she attributes any changes to her thinking to finding source materials via research. Another student (Student #12, who also completed only one mapping narrative, NP3) employs similarly limited engagement with the map-based reflections, responding to the prompt in a brief paragraph with only two comments on how she sees her map: “it shows” (a functional relationship) and “it conveys” (a conceptual act of interpreting the underlying meaning of a multimodal image). As her map structure suggests in Figure 23, there appears to be little construction beyond Assembling/Constructing. Labels employ only listing identifiers (“what it is” phrasing rather than “what it does”), and connective design choices are limited.

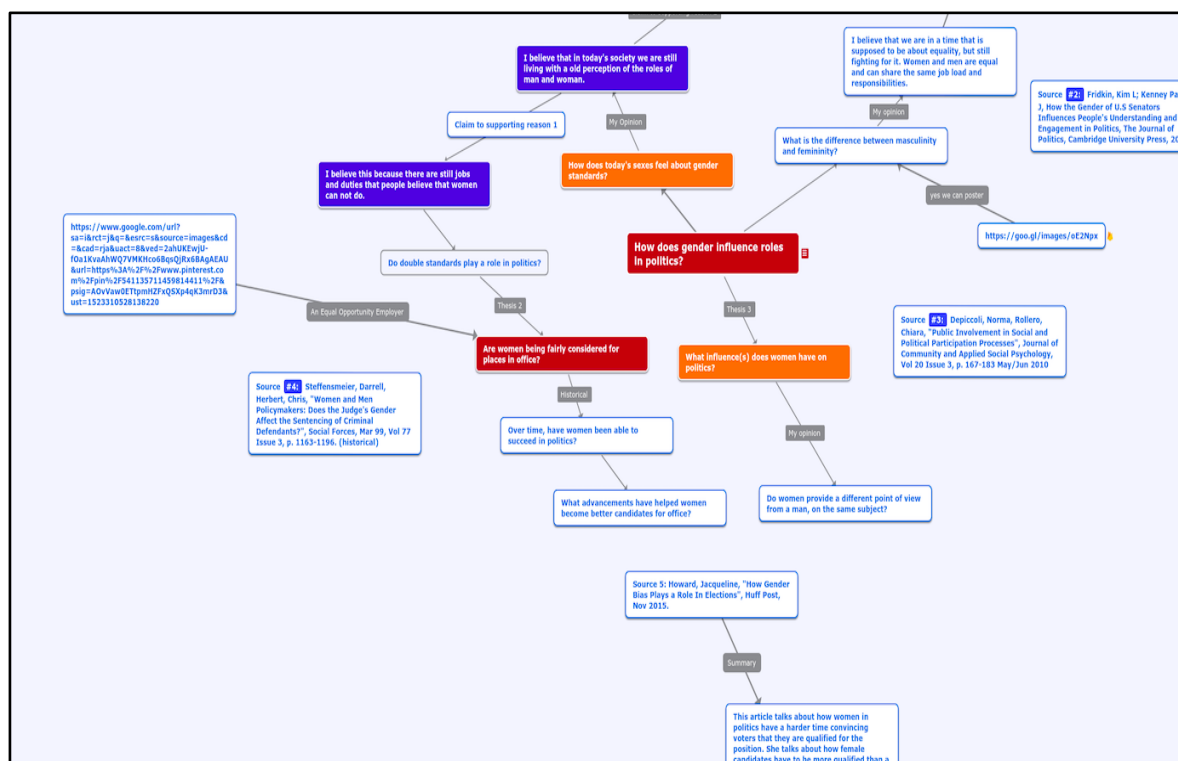


Figure 23: Excerpt from Student #12 Final Map Illustrating Simple Structural Behaviors and Limited Reflection

Another interesting result observed in this third narration is the presence of Agency cues. This is not unexpected, as the language of the prompt asks students to focus on the constructive nature of their choices as contributing to the development of their own ideas and understanding. These cues often appear as “I” action phrasing, such as in terms of their structural choices in the map: “the right side where I have most of my sources” or “when I was connecting” (Student #3). Such structural references may also suggest the formation of mental schema. Agency cues also appear in more cognitively-based conceptual phrasing, such as in Student #11’s comment that “My thinking has *changed* tremendously from my early map into my current map because I have done research on more of the psychological aspects of my argument” (emphasis added). This writer’s observation seems to signal development at the Associating/Generating process level in terms of Incorporating at both a Discovery as well as Conceptual level as the result of the writer seeing a gap in her map that points to the need to augment her early argument’s structural content. Such indicators of Agency provide artifacts that will be useful to my analysis in addressing the question of whether these results correlate in any way with the results found by comparing final maps with final essay synthesis behaviors. Such action phrasing also occurs in relation to their design and visualization choices to develop their Associating/Generating processes.

End of Term: Final Map Thoughts

Because a number of students’ submitted NP work lacked audio or were missing entirely, in the final two weeks of the semester, at the point when students were working on final drafts of the research essays, I asked students to freewrite two informal, text-only reflections on their designing and thinking processes in order to capture a final reflective “look back” at their semester of mapping. (The full prompts are located in the Appendix.) Many of these posts

capture agency-related comments on the *what*, *how*, and *why* of students' map constructions that the three narrated journal entries did not always provide. The purpose of the two posts were intentionally linked, with both completed as in-class freewriting exercises during two separate class sessions (Weeks 15 and 16). The first focused on the granular assembly elements (the how and why of map design features), and the second took a wider, historical view of the significance of their semester-long creation: a visual roadmap of their thinking process at early, mid-semester, and final form. Approximately $\frac{2}{3}$ of the students (10 out of 15) completed either one or both of the entries, a result that may reflect factors other than full engagement in the task (e.g., several students were absent that week, and end-of-semester fatigue had set in). Student comments were quite revealing, especially in terms of their color choice reasoning along with their connection strategies.

All students chose to color code their nodes in some way, following in-class workshop activities that guided them through the map's features as representational and meaning-making affordances. However, as previously mentioned, color use can be quite subjective and any attempt to interpret this as an indicator of agency-related meaning-making by merely observing the maps would be, at best, educated guesswork, especially in terms of higher-level cognitive associational processes. Therefore, for design functions like color, I relied on explicit student comments about their choice and representational influence.

Week 15 Entry on Design Choices

The use of color as an agency-informed behavior provides visible cues to notable development of students' cognitive processing/thinking thanks to the "act of mapping." These final two journal entries also provided other agency-related moves that were both structural and relational in function. These included not only color choices, but comments that alluded to

student motives in affective terms as well as terms of connection and function. All students (n=15) color coded their nodes in some way, beginning early in the mapping process with in-class workshop activities that guided them through the map's features as representational and meaning-making affordances. The following two tables (Table 16 and Table 17) represent a sampling of comments and word choices that appeared across the first of these two final entries (n=13), strongly suggesting that student decision- and meaning-making, in addition to Agency, are facilitated by the map's design affordances. The numbers in parentheses indicate how many students commented specifically on ways each feature was employed. Table 16 contains phrasing used repeatedly across these student entries (with the exception of quoted material, which stand out in some unique way worthy of more precise representation). The Motives/Affective Terms in the second table represent phrasing that appears in all entries except for two posts. This category best captures illustrations of student agency in play. The first quote is uncited because it appears, in various permutations, in nearly all the 11 posts.

| Color Terms (13) | Connect & Function Terms (13) | |
|---|--|--|
| <ul style="list-style-type: none"> ● organize ● keep track ● preference ● emotion ● meaning-making ● used color “to assign a new category” (Student 4) ● color coded to “source” and to “context” (Student 4) ● “how I show key features & how I can tell apart the good and the bad sources” (Student 7) | <ul style="list-style-type: none"> ● that went with ● link ● realize ● remember ● track ● explain ● conveys ● shows ● compare ● connect ● build | <ul style="list-style-type: none"> ● represent ● helped me see ● organize ● grouping ● “breaking my thinking up into sets” (Student 14) ● represent connections ● layout choices to “show that more than one author <i>feels</i> the same way about my topic” (Student 1) |

Table 16: Commonly Repeated Structural and Relational Phrasing Related to Design Features in Week 15 Journal Entry

| Motives / Affective Terms (11) |
|--|
| <ul style="list-style-type: none"> ● “represent how I feel” ● “did not think it was important” (Student 9) ● (color choice reference) “red is important” (Student 4) ● “blue is my favorite color” (Student 9) ● “green is a color of peace and I feel peace is neglected in situations like this” (Student 11) ● “the mood the source gives..portrays the color of how I feel” (Student 11) ● “colors...helped me to convey my emotions to see why some issues...were serious” (Student 3) ● “chose blue to convey sadness to show some of the reasons” children behave because of poor home environments (Student 3) ● altering shapes “when I felt a topic deserved its own shine” (Student 6) ● “the not so great sources on my map are in the color green because that green represents yucky mucus...I chose these sources to <u>show</u> how I was feeling at the time about my topic” (Student 7) ● “colors and features...helped me express my emotions towards how I believe that...” (Student 1) |

Table 17: Motives/Affective Terms Found in Week 15 Student Journal Entry

Student #5, in her post to this journal, provides a summary of what many students' comments were alluding to in some degree or another: “*This way of mapping my thoughts helped me realize* [a cognitive connection at the Association/Generating level of the process] that many of my quotes or thoughts fell *in link* with other ideas I had written down earlier in my writing. It also helped me *remember* what I first thought about the topic [a sign of cognitive offloading and Invention]. *This helped me find* [Connecting-Incorporating-Discovery & Relational] different points of view for my paper [Associating/Generating] because one side of my Mindomo map was a “PRO” side while the other was a “CON” side. *This helped me connect points that could defend BOTH sides of my argument*, but I could really define which one I wanted to argue against the most” [Associating/Generating, Early D&R] (emphasis added).

Week 16 History of Mapping Conclusions

Of the 13 who completed the previous Week 15 reflection, only 4 of these completed the last journal, which asked them to review the history of their map's construction and remark on their perception of progress along their journey as thinkers. (Three of this group were among the few who completed all three Narrated Premapping journal entries, perhaps suggesting a higher level of engagement with the entire process; however, one—Student #9—had demonstrated minimal engagement with the mapping.) These entries *all* contained comments about ways their mapping allowed them to see patterns or discover new connections that they then transferred into their essay writing, and therefore are worth noting here as a continuation of their reflective journaling. The following table (Table 18) captures these results within the Master Code Continuum.

| Sample Student # ⁴⁸ | Assembling/ Constructing (Summary, Listing) → | Connecting/ Linking (Incorporating) → | Associating/Generating (Incorporating, Early D&R) → | Transforming/ Restructuring (Complex D&R, Synthesis) |
|--------------------------------|---|--|---|---|
| | <i>Knowledge Telling</i> | | <i>Knowledge Transforming</i> | |
| Student #2 | Early Application of Color: “to help better organize my map” | | Later Application: “actually looked for connection words in my sources and began connecting them in my map with a label or word showing what they shared in common. I talked about the similarity in my outline (stage 3), actually quoted what the authors said in the articles, and [in] my reasoning or ‘I believe this because’” | |
| Student #3 | Early Application: “The material that I <i>constructed</i> in my map allowed me to help write my drafts and journals by allowing me to <i>organize</i> my thoughts” | | Later Application: . . . [and] to develop my thinking even more to <i>see how things connected</i> and to be <i>able to use those connections</i> to be able to <i>show</i> that the point of view that I wanted to get across as well for my argument. This even <i>allowed me to think more critically</i> and come up with more things that may have been more complex for me <i>if I didn’t have something to help me see</i> ” | |
| Student #9 | Early Application: design choices served a more structural function | | Later Application: perceived relationship between constructing the map and “putting more ideas together” when writing his argument essay | |

Table 18: Student Reflections on Map in Final Journal Entry: Writing Development Over Time as Framed by Master Code Continuum

⁴⁸ Emphasis added to student quotations to highlight examples of conceptualization through visualization.

Comments made by Students 2 and 3 in Table 18 above seem to point to both representation as well as reasoning facilitated by the act of constructing her map (how connections she drew represented meaning making), and assist in her conceptualization of relating materials to serve her larger purpose (argument). Student #9, whose use of the mapping affordances were fairly limited over the semester, muses briefly in his final journal that this lack of fully engaging with the map's affordances and process may have had a negative impact on his writing, stating: "I feel as though I left out several key things that could have helped me even more when writing my paper." In summary, these samples drawn from the final two journal entries seem to point to the inventional potential of mapping as cognitive pre-staging for writing, whether in terms of organization [Assembling/Constructing], constructing new patterns of knowledge [Connecting/Linking, Associating/Generating], and even positioning writers for the Complex D&R of synthesis [Transforming/Restructuring].

This pattern seemed to be reinforced by the single voluntary interview (Student #8) that took place after final grades were submitted. While the call for interviews was broad, only one student agreed to meet with me for an informal Q&A session, making it impossible to draw any conclusions from this data form. However, several of her comments did support other data drawn from class-wide journal responses that suggested the more students used the map in an on-going invention process coordinated with writing efforts, there were observable benefits. For example, when Student #8 was asked to describe how she coordinated map generation with her writing, she stated it was a "back-and-forth" approach: "I did a mix [i.e., back and forth] because at . . . some points I found a lot of information off my Mindomo and a lot of times from my research and I went back to my Mindomo and then when it came time for the real paper I went back to Mindomo." This comment mirrors what the student wrote in her final reflective journal entry

about her semester-long experience, suggesting that the absence of additional interviews may have been offset by my decision to add the two final reflection opportunities before the end of term.

Coding for Mirroring: Data Set 4, Final Maps & Essays

This final data set represents the concluding stage of students' research synthesis efforts, culminating in their finished researched persuasive argument essay and (in the case of the Intervention group) their fully developed Mindomo map design. For this stage of coding, I compared student essays to their maps, looking for markers of correlation and/or repetition. For the purpose of setting up a wider comparison and triangulation, I also examined data provided by the Control group in sets: one early writing example plus the final research essay for any similar markers. The potential for mirroring between essay and map was examined in terms of the categories from the Master Code Process Continuum.

Intervention Group Sets

I looked at a number of factors in this set: the number of mapping moves made by the student (provided by the Mindomo program), organizational and construction/connection elements (connector links—connective vocabulary), and representational features of the map that might mirror in some way to the students' essays (connector links, label vocabulary, node vocabulary, and any other design elements that have been previously noted to serve a meaning-making purpose). While coding, analytical memoing provided detailed observational content towards this stage of reporting. In reviewing these memo notes, along with student work, a number of generalizations emerged regarding mirroring patterns. These were generalized into 5 categories based on the relationship between the map's coding and the final essay's coding for patterns of behaviors that appeared:

1. There was complex map design (KD⁴⁹ or multi- or relational-structural), but the final essay was markedly less so (KC or unistructural);
2. Simple map design (KC) corresponded to simple structural essay (KC);
3. Complex mapping (KN) translates into mapping-related journaling but not into the final essay (KC or some KD);
4. Complex map mirrors to complex essay; and
5. Negative mirroring, or absences of concept and knowledge building in one corresponded to same absences in the other.

Often, in places where students' maps contained complexly developed areas, there were corresponding text paragraphs with similar Associating/Generating markers. More frequently than not, when a student's essay was unistructural⁵⁰ (consisting primarily of Listing/Summarizing at the Assembling/Constructing level of the Process continuum), so too was the map. Out of the 15 students of the Intervention group, there were 3 whose maps were actually *more complexly* constructed than their essays. Students 1, 4, and 11 submitted final maps that were Multistructural (demonstrating Incorporating as well as some degree of D&R) or—to some degree—early Relational (incorporating D&R and some synthesis moves), but their essays were less complex (Unistructural). This difference may reflect a number of factors in play; for example, Student #4 had submitted very little in the way of prewriting work, which in turn meant less feedback for revision writing. Another factor may be related to difficulties translating the

⁴⁹ These coding labels are discussed in some depth earlier in this chapter, but briefly: KC = knowledge combining or juxtaposing, KD = knowledge developing, and KN = new knowledge or meaning making.

⁵⁰ These terms Unistructural, Multistructural, and Relational have been adapted from Campbell et al. and previously been defined in the Literature Review. They are only briefly defined here for clarity. It is important to reiterate here that the continuum range from Unistructural to Relational does correspond to Flower's graphic demonstrating Low to High Transformation ("Reading to Write" 64).

less formal visual representations to more formal academic textual structures, despite several scaffolding tools (like SIEL) designed to help support that move.

Other patterns included corresponding design moves (assembling, connecting, associating, and transforming), label terms (functional, relational, or conceptual) identified along the same continuum, as well as indicators of Synthesis Continuum behaviors (listing, summarizing, etc.), all of which are incorporated in the Process Continuum Master Code List. These patterns emerged after using the following Evaluation Coding Matrix: Transfer Checklist, which I built to compile notes from memoing, and are illustrated below in Figure 24.

| Represented as Presence / Absence | PROCESS JOURNALS | MAP NARRATION JOURNALS (3) | FINAL ESSAY | FINAL CONCEPT MAP |
|--|------------------|----------------------------|-------------|-------------------|
| LABEL TERMS: Assoc/Connect | | | | |
| Functional Terms | | | | |
| Relational Terms | | | | |
| Conceptual Terms | | | | |
| DECOMPOSING/RECOMPOSING | | | | |
| Complex (>) | | | | |
| Simple (<) | | | | |
| DESIGNING MOVES: Visual/Text | | | | |
| Assembling/Constructing | | | | |
| Connecting/Linking | | | | |
| Associating/Generating | | | | |
| Transforming/Restructuring | | | | |
| SYNTHESIS CONTINUUM (Low-High)¹ | | | | |
| Listing | | | | |
| Summarizing | | | | |
| Incorporating | | | | |
| Decomposing & Recomposing | | | | |
| Synthesizing | | | | |
| Range of Cognitive Structuring COMPLEXITY² | | | | |
| Unistructural | | | | |
| Multistructural | | | | |
| Relational | | | | |

Figure 24: The Evaluation Coding Matrix: Transfer Checklist Tool Used to Detect Patterns Across Data

Control Group Sets

I must note here that there were a number of problematic variables among the Control Group materials provided by the three instructor volunteers. Despite my best efforts to acquaint these instructors with the nature of the materials I was looking for (see letter in Appendix C with the instructions provided to these instructors), the inevitable “messiness” of studying authentic classroom-situated environments led to variables best described as unforeseen. Even though our curricular guidelines called for common assignments, instructors were at liberty to rely on a variety of prewriting activities to teach those assignments. This was anticipated, and indeed is part of the study’s framework, but I did not anticipate the widely varying materials submitted to me by my colleagues as prewriting samples, which varied even more from instructor to instructor. This contributed to my decision to limit the process materials to one and one: one prewriting process sample containing *any* synthesis-like constructions, and the corresponding final essay. Another negative factor was the submission by one instructor of only “A” papers, rather than a random sampling. Further complicating this was the instructor’s decision to include grading comments/feedback with the samples; therefore, to avoid any risk of bias, I did not include this set with the rest.

The Control Group sample sets were reviewed for the same types of markers as were used to examine the Intervention materials: organizational and construction/connection behaviors (e.g., outlining and prewriting paragraphs’ construction choices, as well as vocabulary indicative of synthesis attempts). I also applied the same system of coding as was used for the Invention group, looking for markers of creation and cognitive processing (both synthesis components), as well as factors of agency in terms of students’ materials using the Master Code List of Process Continuum. The remaining two sets of samples included a final research essay and students’

expanded outlines (considered prewriting process work). These outlines were expanded in the sense that they included (in one set) student reflective commentary on the “why” of each section’s design, and in another set included detailed language of connections in full sentences, providing me with phrasing I could mark for label terms (association/connection terms), as well as for Designing Moves and Synthesis Continuum elements.

I discovered similar patterns as I found in the Intervention group, at least in terms of parallelism between the prewriting and the final essay. While Control Group 2 did provide reflective/reasoning passages in the prewriting, Control Group 1 did not, minimizing the scope of possible comparisons to the Intervention group in terms of synthesis behaviors. The materials provided by the Control group instructors also did not provide requested examples of early synthesis writing samples (early semester, mid semester, and late semester) to allow for observations of progressive growth along the relevant coding areas. However, it is still interesting to note that from 5 out of 9 complete sets submitted, the process materials largely mirrored those behaviors found in the corresponding final essays in terms of coding categories. Especially relevant among these are the categories: Range of Cognitive Structuring Complexity (uni/multi/relational structural) and the four primary themes of Designing Moves (Assembling, Connecting, Associating, and Transforming). These patterns suggest that when a student’s prewriting materials point to more complex design moves (e.g., Associating/Generating), this transfers into the final research essay. Of all the sets submitted as Control, only one exhibited passages containing early synthesis/D&R constructions with Transforming/Restructuring knowledge building practices in evidence. However, without a clear sense of what students’ early synthesis writing might have looked like, any observations about student learning as related to assignment heuristics would be premature based on these materials.

CHAPTER V

ANALYSIS & DISCUSSION

This chapter will be organized according to my study's three guiding Research Questions. However, before proceeding, I must begin by discussing some of the limitations encountered as they do impact my reading of the results. These limitations will also be revisited in the Conclusion as part of anticipating their impact on future research and iterations of this interventional approach to synthesis instruction. Following these limitations, I move on to triangulate and discuss results of the study through the lens of my research questions. More specifically, my analysis discusses patterns and repeating strategies observed in students' processes from mapping to writing, including markers for structural, complex conceptual, and meaning making (KC/KN/KD), as well as patterns of transfer and translation. Finally, my analysis turns to the impact of this intervention on student concept building processes in essay writing, using the results of the Master Coding List Continuum, including Control data, to consider any possible impacts of concept mapping on student synthesis construction behaviors in terms of knowledge *telling* vs. knowledge *transforming*.

Limitations

In the process of conducting this study, several limiting factors occurred that are significant enough to warrant a brief discussion. These included several variables divided into two areas: environmental (including technology and pedagogy) and data collection issues.

Environmental Issues

During the study's implementation, we lost several days early in the semester due to weather-related school closures and instructor illness/absence; these occurred during the first stage of invention (topic discovery), resulting in a trend of "getting behind" that cascaded into

later weeks. This created a backlog of planned scaffolding tasks intended to introduce students early on to concept mapping *and* the cognitive research behind it to afford explicit instruction, as well as more “buy in” and agency with the intervention. In addition, the number of days devoted to in-class modeling and guided practice were reduced due to several days of instructor illness. This may have impacted the degree to which students were able to develop confidence using the mapping software and the cognitive theory behind it.

Technology and classroom space were also environmental factors. The Intervention classes were held in the same dedicated technology-equipped classroom. However, students were forced to endure *two* classroom changes when our original classroom suffered structural damage (water leak). The original classroom learning space was designed as a constructivist, learner-centered environment, in which desks were arranged in a pod-like pattern, allowing an uninterrupted line-of-sight between students-instructor and student-to-student.⁵¹ This environmental design was intended to afford collaboration among students while mapping, in keeping with the study’s design-based methodology emphasis on student agency and roles as knowledge designers. However, due to the aforementioned shifts in location and technology, the classroom design may have been less effective, although students were still encouraged to collaborate. Another environmental variable was the unreliable internet connection in the new classroom (i.e., post move), which frequently led to impacts on time devoted to modeling and collaborative map work. This may have led to some students’ difficulties signing into and working in the concept mapping platform (Mindomo). In-class journaling activities (which took place in our LMS) were also compromised on a few occasions when the LMS failed, leading to frustration and disruption of processes.

⁵¹ An overview of the theory behind this environmental factor can be found on Yale’s Poorvu Center for Teaching & Learning page, “Classroom Seating Arrangements.”

Platform familiarity was another (and not unexpected) variable. Even though extensive class time was allowed for adapting to the concept mapping software (Mindomo), initially 3 out of 35 students incorrectly followed the guidelines for setting up their map space within the instructor's Mindomo classroom account, resulting in some "lost maps" (this was eventually corrected). Other technology proved more troublesome. Students reported a number of difficulties with the software used to record their map narratives: oversized files crashing their system, sound capture failure, etc. This was addressed as we moved through each premapping journal (NP1–NP3) with adaptations. For example, for the first concept map (NP1), students were encouraged to use the voice-over feature of PowerPoint, but were allowed to record with their smartphones at the request of a few students (producing a MOV file, notorious for its size and lack of portability). For the second concept map entry (NP2), in addition to the narrated PowerPoint option, Screencastify and Screencast-omatic platforms were introduced as an alternative to the MOV file. Students' difficulties decreased with these software options, yet it appeared to play a minor role in some students' declining participation in posting additional narrations as the term progressed.

Data Collection & Design Issues

Several features of my study's design, notably in terms of data collection, will need to be reexamined prior to undertaking future iterations. In my early review of questionnaire data from the Intervention and Control groups, I noted in my memo record that there were no provisions made for any way to correlate the post-questionnaire results to individual map work to see if there were any parallels between students' engagement in the mapping process and their agree/disagree response ranges. While final journal entries were added at the end of the term to

compensate for this direct data gap, this will likely be addressed in future iterations, or be the basis for a future research project. Other data limitations include:

Control Group Samples: As previously mentioned, there were several unanticipated variables in the types of data returned by the instructors of the three Control classes. Even though instructions made to three instructors included explicit directions to capture a “range” of synthesis writing samples (see Appendix C for Letter to Control Instructors), the sample set of Control Group 1 was skewed toward *only* successful student writing (instructor’s note indicated all samples were “A” papers). Even though these were set aside as biased, coding them revealed only one student of three successfully synthesized (i.e., created) passages coded as KN/D&R. Among all three Control Groups, the variations among materials returned also led to unusable data. For example, one sample essay submitted as part of Control Group 3 was not a research essay at all and had to be discarded/disqualified (no source use at all). This resulted in a smaller than expected data set (only 5 as opposed to the original 9 planned).

As described in the Methodology chapter, each major assignment across all sections of this course are required to share the same core features and outcomes (see Appendices C and D for sample assignments from both Control and Intervention instructors). Minor or process assignments (like paragraph/synthesis passages for workshop) are not so universal. Even though the same open source textbook materials were used, none of the mandated readings focused specifically on the synthesis process other than a common paragraph building tool referred to as SIEL (Statement, Illustration, Explanation, Link).⁵² Samples cannot take into account different teaching methods (the Control group instructors did not use mapping) and varied ways of presenting textbook materials specific to individual classrooms, introducing a potentially

⁵² Previously described in Footnote 46 in the Results chapter.

problematic variable difficult to clearly account for in analyzing and triangulating results. This likely created the potential for irregular variables, making clear correlations “iffy.” In future iterations of this study, it might be better to return to an earlier iteration in which all groups (control *and* intervention) are drawn from my own courses, thus reducing the potential for uncontrolled variables in teaching materials other than the map use. Still, since the purpose of the comparison is “map/no map,” these variations may not be significant. However, the next iteration needs a significant modification to the makeup of the control group. The most likely solution would, at minimum, have all instructors agree to at least ONE synthesis teaching activity in common and draw sampling from this. The more likely solution would be to invite all instructors to be part of the IRB as co-researchers and collaboratively minimize discrepancies.

Intervention Group Samples: Initially, the plan was to take a cross sampling of research essays and maps from three groups of students (n=9) based on degree of journal completion. However, in the end I examined all qualified research papers and maps (n=15) because of the small sampling size of the study. While this added to the time intensiveness of coding, I felt this was necessary to better capture the scope of students’ responses and reduce the risk of researcher bias.

Instructional Material Issues

In order to fine tune the study’s design, any future iterations will need to include *more* in-process interviews with students during the semester. This would conceivably allow me to record a discussion with students to better elicit/guide responses to questions of “why did you choose this, and what did it do for your thinking?” This will be discussed in greater detail in my Conclusion, but here it is sufficient to observe that allowing students to self-record gave far too

much leeway to students simply “telling” the contents of the map, overlooking explanations of the “why” of their design choices.

In addition, in an attempt to avoid unduly influencing students’ map construction choices, which might then skew their results, my feedback to students on their map structures was limited to modeling and guidance on using affordances as representation strategies for patterns and connections, which included a vocabulary sheet of synthesis terminology that could go into their labels. In theory, this may have helped the research remain unbiased, but in practice may not have been effective pedagogy. As Hyerle points out in his section on effective use of concept mapping (61), providing students with explicit guidance on how to more expertly use the software is key to lessening any negative impacts on their learning to synthesize. However, time spent in class workshops modeling the mapping process was often dedicated to overcoming the “wonkiness” of the space (unexpected moving elements, learning the features, problems with account access). While I had hoped to avoid the trap of “teaching to the technology,” it appears to be a variable in my instruction that may have simply been unavoidable. That said, in trying to teach synthesis not teach the software, I may have glossed over potential instructional opportunities for *explicitly* teaching the *act* of mapping with the potentiality of its metaphoric *cognitive* representation—i.e., what mapping physically represents cognitively—something that a new iteration should address. In sum, I believe modifications to journal instructions are needed to create more clear, direct response prompts, which I initially avoided for fear of “leading” student responses (and thus infringing on agency). All of these concerns will be discussed in more depth in the final chapter.

Triangulation: Identifying Intersections

To analyze these findings, I examined results in terms of the function-based patterns represented across data groups: repeating elements, translation (meaning making), and transfer (crossing over). More specifically, I looked for suggestive patterns within the results that correspond to: (1) what *repeats* across data sets and throughout the students' processes; (2) what mapping activity and design elements *translate* into students' essay writing; and (3) what indications are present that *representation processing* (i.e., making assembly/connection/association choices in their mapping) *transfers* into student synthesis efforts or even represents a cognitive process-based learning activity. While doing so, I noticed three core concepts were present across all four data sets (as well as the Control group): epistemic abilities, cognitive processes, and strategies for structuring knowledge. Triangulating these patterns and concepts provided me with a way to interpret these data in light of the study's three research questions and my analysis framework (illustrated in Figure 25 below).

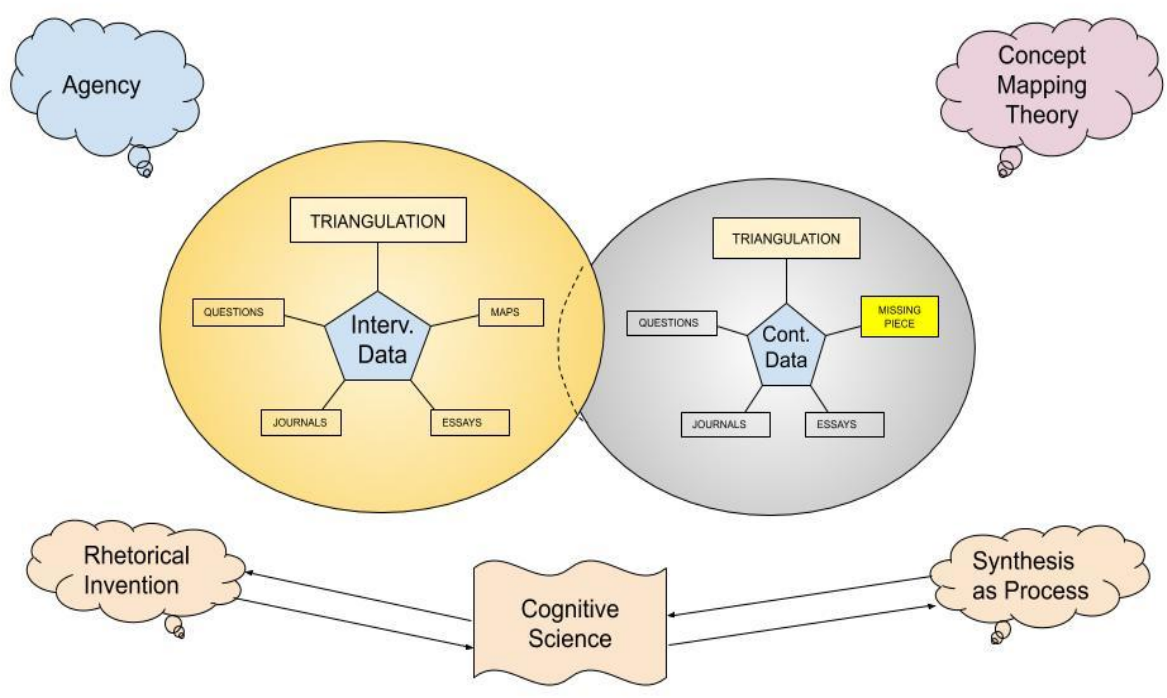


Figure 25: Illustration of Analysis Framework

Table 19 is intended to capture an overall set of generalizations to provide a foundation for the analysis of these intersections that follow. It is divided into connections between data sets based on their intended function. In the next column are the general results of two rounds of data coding, followed by triangulation efforts as previously described in the Methodology and Results chapters. In the final column are summations of my interpretive leaps that are the result of applying the Master Coding List to discern patterns among data and findings.

| Data Set Connections | Findings | Observations/Generalizations |
|---|--------------------------------|--|
| Questionnaires & Journal entries: Students' Beliefs About Knowledge & Meaning-Making | Repeating elements or concepts | <ul style="list-style-type: none"> • Reflections provide artifacts of student motivation/agency on occasions of cognitive processing (invention, synthesis) |
| Map to Journal to Map: Connections of "Why" Knowledge (Intervention Only) | Translation | <ul style="list-style-type: none"> • Early examination of Intervention student journaling and map use suggests there may be a correlation in terms of higher representation of D&R, Discovery, & Relational Association markers when maps are complexly connected with journal contents that explore the cognitive-connective "whys" of student processes. |
| Journal to Essay Content & Strategies: Mirroring | Transfer | <ul style="list-style-type: none"> • When student journaling reflection is <i>not</i> present, or the focus is off topic, mirroring seems less evident. Of course, in the absence of in-process face-to-face interviews, such a conclusion is an inductive move at the most, an educated guess at least. • Viewing maps' history feature as construction process: when contextualized with timing of guided construction lesson plans, the Mindomo map history feature is a potentially useful tool. Only 4 students completed the reflection journal associated with a review of this history, making it of limited use for analysis. |
| Map to Essay | Transfer & Translation | <ul style="list-style-type: none"> • Student Comments: some student journals contain explicit comments on their perceived connectivity. Journal entries focused on making correlations between map building choices and writing the research essay seem to suggest metacognitive transfer at work. • Often detected patterns such as "when KC and KD are both present, KN or early KN also happens" (see Table 13 in Results). |

Table 19: Summary of Intervention Data Connections, Findings, and Generalizations

Concept mapping's impact on student epistemic abilities is explored here within the context of research into cognitive mental schema building that results from reflective and scaffolded active learning practices. Several patterns and categories of patterns emerged from

analyzing the results presented in the previous chapter. These are generalized in terms of the relationship between or mirroring of knowledge-building practices previously coded as KC, KD, KN.⁵³ The sections that follow explore these patterns as they relate to the study's three main research questions:

1. In what ways does the interventional, hermeneutical heuristic of digital concept maps impact students' epistemic abilities. Specifically, if we can teach students to view synthesis as a cognitive process of structuring knowledge, what benefits might be realized?
2. What role might DCMAPs as visual representations of student constructions (connections) and knowledge conceptualization play in promoting active and progressive transformation of ideas?
3. Can MBE scholarship and theories, when combined with an understanding of Information Visualization as a *cognitive* process, productively inform assignment design for synthesis and research writing in the FYW classroom?

Mental Schema & Agency

A brief discussion of student agency (as defined in an earlier chapter) is warranted prior to discussions of specific findings, as it relates to the correlation between developing cognitive processes of complex concept building and novice-to-advanced range of experience. My Research Questions focus on students' epistemic abilities related to synthesis, particularly as they enter the course as first year writers (FYW) and potential novices to the higher academic discourse community and its epistemic conventions. Results from the data appear to suggest a

⁵³ KD=developing knowledge (*shows, learning, reveals, proves, adds, means*); KC=combining knowledge (*juxtaposes but little to no integration*); KN=new knowledge (*meaning making, result of agency-driven integrating others' knowledge with prior knowledge*)

notable uncertainty or lack of confidence expressed by both Intervention and Control groups, as seen through pre-questionnaire responses that focus on student's prior experience (i.e., pre-existing knowledge) with synthesis. For example, a comparison of results from questions Q1 and Q5 seems to suggest a disconnect between students' synthesis definition and identity as knowledge creators. This raises the question: just because students perceive personal experience as *useful*, do they understand or practice *invention* (or at least, co-inventing) employing that experience? This result may reflect a misunderstanding of invention and what it means to *construct* "new [knowledge] paths" by contributing *plus* transforming knowledge (Barzilai and Zohar "Epistemic Thinking"). This seems to bear out when correlated with their synthesis writing samples, which suggest more KC and KD than KN happening. It is important to keep in mind, however, that *most* students from the Intervention group whose mapping demonstrates more complex connections wrote essays that contained more instances of developing D&R (i.e., early movement from relational to conceptual knowledge building) than those students whose maps and essays were both simple-structural (unistructural). This difference may suggest that this is a common epistemological state for incoming first year writers, especially when it comes to synthesis expertise.

This uncertainty or novice-agency is also evident in the Intervention group's reflective journal passages and early synthesis writing efforts. Such observations come as no surprise, considering my earlier discussion of novice-to-experienced writers in the Literature Review. What is significant for this study is the presence of several interesting trends related to my questions of student agency and its role in developing more successful acts of synthesis writing. For example, questionnaire results from the Intervention group suggest that when students see themselves and/or behave as knowledge co-creators when aided by the generative conventions of

concept mapping, there appears to be more frequent occurrences of reflective cognitive *self-awareness* behind their meaning-making choices. Journal reflections appear to affirm this when students articulate metacognitive connections between what they *do* in and through their maps and how they *see* those connections potentially transfer into written meaning making as part of their synthesis writing efforts (see Table 12). This is in line with Flower's assertion that when we apply the cognitive lens to writing processes, we recognize writing—and all its related intentional processes—"in terms of actions more than text . . . to see the writer as an *agent*" ("Reflection" 335; emphasis added). This is not only beneficial to disciplinary researchers, but to students' self-awareness and situated practices as well.

Agency is also a key factor in students' generative meaning-making processes as facilitated by their mapping, and signs of intentionality from student journal results appear to suggest concept mapping has some degree of impact on promoting constructive epistemic abilities. As seen throughout coding results for Data Set 2, students' explanatory reflections related to their mapping visualization choices and their meaning-making intentions appear to demonstrate mindful performance of relational intent when actively structuring knowledge. Results from students' map-designing journal entries also suggest that student decision- and meaning-making (i.e., agency cues) are facilitated by the map's design affordances. As indicated throughout the Results chapters devoted to journal results, these entries suggest the more students used the map in their on-going invention process, when viewed in coordination with writing efforts, there were observable benefits manifesting as expressions of cognitive processing (terms of discovery, seeing, making new connections, finding meaning). This is most visible when tracked as a developing process using the Master Code List Continuum in examining Data Set 3, which examines knowledge designing moves in students' concept map construction.

Agency in cognitive processing is explicitly examined in these results and appears to manifest as representational mapping behaviors. For example, coding suggests that when student mapping is complexly connected to journals that explore the cognitive-connective “whys,” the level of Discovery, Relational, and D&R (Deconstructing and Reconstructing) markers seem more pronounced or frequent in student writing samples. Further, while mirroring between student maps, journals, and final essays may not always overtly manifest in terms of transferring vocabulary use, efforts to triangulate mapping journals for students’ “back stories” of their reasoning reveal additional correlations. For example, when students’ journal reflections are either not present or off-focus, or the map/mapping is simplistic in effort or construction, any mirroring of schema-building into essay synthesis passages seems less evident. While other factors for this may be in play, this lack of transfer could suggest that the combination of the *active process* of mapping and students’ overt reflection on their personal constructive meaning making efforts is more likely to productively transfer to students’ final synthesis efforts.

This result aligns with Eppler’s conclusion that a complementary approach to designing a synthesis heuristic, combining visualization (concept mapping) with other metaphoric teaching approaches (e.g., building new knowledge is synthesis) enhances learning. This may be due to the way this intervention facilitates *scaffolded pathways* for novice student writers to create or recognize “meaningful patterns of information” (*How People Learn* 32). The ongoing, multifaceted, and progressive process of the intervention’s design creates scaffolded layers of strategy building activities to promote students’ epistemic agency as active builders in terms of how they choose to “chunk information” using recursively related design, reflection, and writing (*How People Learn* 32). Results gleaned from the post-questionnaires and final journal responses discussed in the previous chapter seem to suggest that students are seeing these benefits emerge

in their thinking and in their writing processes. For example, students' early use of CMAPs appears to reflect more constructivist rhetorical behaviors of structuring (organizing and planning). This is not altogether surprising, given most students had indicated experience with graphic organizers was part of the K-12 prior writing experience. This also illustrates my study's premise that synthesis is an inventional *process*, not merely a rhetorical artifact, that requires *intentional development* over time through *both* structural and cognitive instructional activities. Table 12 illustrates three categories that carry over into other data sets, providing both rhetorical and cognitive indicators of a potentially significant connection between students' mapping and development of their learning to conceptualize (create new ideas; figure out; seeing; help me explain). Such markers of generative and inventional behaviors translated into coding across the Process Continuum (Assembling/Constructing—Connecting/Representing—Generating/Associating—Transforming/Restructuring) when correlated to students' final essays.

There is a notable correlation observed in coding Intervention students' journals, maps, and essays that seems to bear this out (see Figures 12 and 13). Such trends may suggest a process-based development that is directly influenced by asking students to engage in active *designing* of constructivist meaning-making paths of map making that then carries over into their writing. This is a *cautious* observation due to the small sample size of this study, but noteworthy nonetheless, given research by both writing scholars (Prior; Lunsford; Lauer; Segev-Miller) and neuroeducation/cognitive scholars (Wittrock; Paivio and Walsh; Petrie and Oshlag) into meaning-making best practices. In fact, in his much-cited research on the nature of the brain's generative learning processes, Wittrock studies a model of learning and teaching that "deals with the effects of generation of meaningful relations—among concepts and between knowledge and experience—on learning from teaching. These generations include and extend beyond the

relations among individual words to sentences, large blocks of text, images, and procedures that *characterize meaningful learning* from instruction and teaching" (531-532; emphasis added).

Based on my results, this seems to be affirmed by a comparison between Intervention and Control groups.

This does not mean that students' final essays consistently translated these benefits to demonstrate "expert" synthesis writing. However, because the goal of this exploratory study was to more deeply develop novice student awareness of synthesis as an intentional, *cognitive process*, the epistemological bridge formed between students' visual performance and their writing *purpose* through facilitating patterns, translation, and transfer points to concept mapping's impact on student *thinking*. The following sections further explore the occurrence of such patterns, translation, and transfer as they relate to the study's three guiding Research Questions.

Research Question #1: Epistemic Agency & DCMAPS

Question: *"In what ways does the interventional, hermeneutical heuristic of D-CMAPs impact students' epistemic abilities (specifically what benefits are realized when we teach students to view synthesis as a cognitive process of structuring knowledge)?"*

As suggested in the preceding chapter, a number of trends from the four sets of data seem to suggest a correlation between the intervention and students' epistemic experiences in constructing the types of knowledge schema related to synthesis learning processes. In the case of the Intervention group, data across all four data sets (questionnaires, journals, maps, and essays) suggest concept mapping had a positive influence on students' epistemic abilities.⁵⁴ In the case of whether concept mapping had any discernible effect on students' conceptualization

⁵⁴ Epistemic abilities are defined here as those practices or behaviors that are based on or reveal "personal ideas about knowledge or knowing" (Barzilai and Zohar 39).

and practices of knowledge construction (i.e., synthesis-as-cognitive-process), I looked for emergent patterns, transfer, or translation among processes between questionnaires-to-maps, questionnaires-to-writing, maps-to-essay, and maps-to-reflective journals. In doing so, I discovered that artifacts collected from students do point to a trend of positive benefit in terms of thinking deeply about their research and writing decisions. For example, results from map design journal responses seem to suggest that student decision- and meaning-making, in addition to Agency, are frequently facilitated by the map's design affordances. Further, journal entries overall suggest that the more students used the map in an on-going invention process coordinated with writing efforts, there were observable benefits. This would be in line with studies cited by Barzilai and Zohar that explain "epistemic thinking" develops as a process "with age and experience as students grapple with the challenge of coordinating the objective and subjective dimensions of knowing . . . in the course of everyday knowledge judgments and knowledge construction" (40). As opposed to Control group results, Intervention students' engagement in concept mapping as a constructive epistemic practice, when coordinated with reflection and corresponding translation into written synthesis passages, seems to provide an additional and cognitively richer area for "grappling" with this intersection of the objective and subjective.

Developing epistemic thinking requires the development of mental schema, and Brulliard and Baron write that as "each individual develops mental schema or 'mind maps'" while constructing a concept map, this process "serve[s] to inform future thinking or action. These schemas are fundamental to the way we understand all experience" (331). These schema, and the evidence of pattern-building cognitive behaviors employed by students to create them, provide one means of addressing my first research question, and help me explain the generalized examples of patterns, transfer, and translation emerging during analysis. Using MBE and concept

mapping scholarship as a guide to my analysis, the formation of mental schema appears evident in the patterns of reflection emerging from students' recursive activities of mapping and journaling, along with some (less overt) evidence of students transferring these same schema over into student essays. It seems significant that the Intervention group was provided with more diverse opportunities for reflection—on multiple planes—than the Control. For example, while the Control group reflections on synthesis efforts appear only at the end of the process (in their pre-essay outlines submitted just prior to final essays), the Intervention group practiced long-term, ongoing reflection based on visualization and conceptualization practiced through concept mapping as well as written text.

General Schema Patterns for Analysis

In order to prepare for a discussion of the intervention's impact on both groups (intervention and control), the Table below is structured to show the parallelism of coded evidence. These patterns support my assertion that students' map creating serves as a representation of their ideas and processes facilitating creation of conceptual relations, and as a means of promoting the epigenetic, generative types of constructions related to successful synthesis. (Categories 2 and 4 may be most significant, suggesting that what is created in the map reflects the type of conceptual, mental schema building work seen in the essays.)

| Intervention Group | Control Group |
|--|---|
| 1. complex map design (KD) but text essay is less so, more unistructural (KC); | 1. complex prewriting (KD) but text essay is less so, ore unistructural (KC); |
| 2. simple map design (KC) and simple structural essay (KC) | 2. simple prewriting/outline (KC) and simple final essay (KC) |
| 3. complex map design thinking (KN) translates into Journals but NOT into the essay (KC or KD) | 3. (no corresponding design step) |
| 4. complex (KD-KN)=complex (KD-KN) | 4. complex prewriting (KD-KN)=complex essay (KD-KN) |

Table 20: Parallel Trends in Intervention Vs. Control Group Results

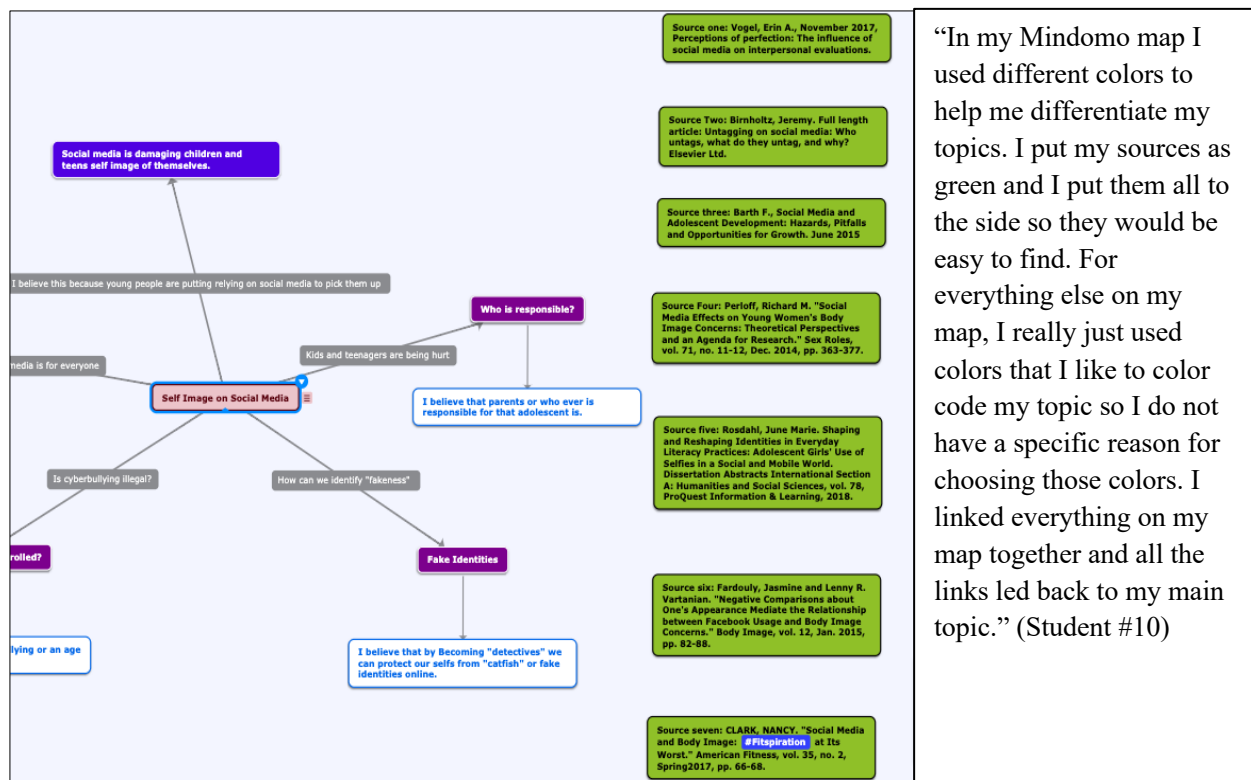
Table 20 illustrates the major patterns, as well as sites of transfer and translation, observed across the study’s data. Not only are these patterns of construction, but traces of mental schema building as well. As Flower explains in her work “Navigating Academic Discourse,” during the synthesis process, “[r]eaders do not simply absorb and store information, they *create meaningful interpretations* through selective attention, connections to prior knowledge, and evaluation of what they read” (225). In other words, schema building (creating meaningful interpretations) requires intentional, enacted cognition activities to help students “see” potential for creating these connections (Hutchins). This is the *transforming emphasis* mentioned by a number of both cognitive and writing scholars (e.g., Hardiman; Hyerle; Kaiser Lee; Kellogg and Whiteford; Mateos and Solé; Prior; Segev-Miller; Spivey) required “to build a *rich and integrated personal representation of a text*” (Flower “Negotiating Academic Discourse” 225; emphasis added). For novice/novitiates to academic discourse, this may be a tall request because students in this study are in transition from one community to the next, and many of their familiar strategies (e.g., 5 paragraph essays)—considered prior knowledge—are no longer

accepted as the standard construction for task representation. The importance of “knowledge transformation” to synthesis is part of this equation. As Flower observes, this transformation or “shift from knowledge telling to knowledge transforming” is difficult to do, in part due to inexperience in conceptualizing strategies and practice (“Negotiating” 225). This epistemological gap-leaping phase of “schema building” is complicated, involving a process of selection, connection, and organization of information. Analyzing these resulting patterns as indicators of this shift reveals this process is manifested in a number of ways throughout student samples and seems to foster the type of reflection that makes explicit students’ cognitive processes. Based on what I see in my analysis of the Intervention group’s artifacts, the concept map appears to provide transition assistance in a scaffolding medium that facilitates—even encourages—knowledge transformation behaviors in a number of ways, and at a number of cognitive levels, that demonstrates restructuring, both rhetorical and cognitive.

For example, results from Intervention students’ maps and journals point to this happening in a progressive manner over the course of the semester. Given Jonassen et al.’s description of “restructuring knowledge” (7)—akin to Segev-Miller’s discussion of transforming knowledge as synthesis— invention defined as synthesis happens when “[t]he learner begins to *restructure* his or her knowledge by adding schemas or developing new conceptualizations for existing ones” (7). Asking students to actively and reflectively engage in *constructing* a DCMAP of their knowledge building process while incorporating their existing knowledge with newly found knowledge is an act of knowledge restructuring (a mental schema), which thereby situates students in this study as *inventional agents* as they *performatively* visualize this process in a digital CMAP structure. This is one of the reasons I selected Mindomo as the class mapping platform: the very affordances of the CMAP space in Mindomo give students a space that resists

the more hierarchical, linear patterns of meaning making afforded by writing only (and even other mapping programs), promoting more flexible creative opportunities for both association-based connections and representations of *perceived* relationships. As the Results chapter illustrates, student journal entries frequently refer to the impact of this creative affordance on their decision- and meaning-making (“the map lets me see/do...”). Based on these data, this freedom to *personalize* connections and representation, as well as pre-visualizing creating and ordering relationships, appears to broaden students’ epistemic awareness of new potential patterns for constructing meaning.

In their comparison between using concept maps versus text to produce verbal coding for meaning making, Nesbit and Adesope suggest that maps appear to “be more effective than text in facilitating verbal coding” by “visually integrat[ing]” complex concepts into the form of nodes (419). As an illustration of this theory, Intervention students’ journals frequently made comments on how the mapping “helps their thinking” or “help them stay organized” as opposed to simply writing out their arguments. Specifically when using node placements, design choices, and labeling, student maps like that of Student #10 in Figure 26 below appear to reflect Nesbit and Adesope’s explanation of nodes’ conceptualization function: “[p]lacement of nodes may reduce cognitive load by reducing the visual or memory search required to distinguish or associate similar concepts” (419). Figure 26 juxtaposes Student #10’s map with her final journal entry on design choices, in which she explains how her use of color helps her “differentiate my topics,” as well as placement choices, setting color-coded nodes “to the side so they would be easy to find.”



“In my Mindomo map I used different colors to help me differentiate my topics. I put my sources as green and I put them all to the side so they would be easy to find. For everything else on my map, I really just used colors that I like to color code my topic so I do not have a specific reason for choosing those colors. I linked everything on my map together and all the links led back to my main topic.” (Student #10)

Figure 26: Student #10 Map to Journal Comparison

In other words, the recursive and intentional pattern of students’ map-reflect-write loop allows students to practice what Winn (as quoted in Nesbit and Adesope) refers to as the “pre-attentive visual processing of diagrams, such as visual chunking of collocated objects” in more immediately accessible ways than linear text may allow (418). Such processes of visual design require ongoing cognitive interpretation, moving from text to visual construction to text; when students are asked to represent this interpretation through map construction and reflective writing, students are in fact engaging with the hermeneutical-heuristic feature of invention-as-creation. My study’s results appear to support Kantz’s observations that learning activities that require interpretation rather than reproduction, along with “an emphasis in the classroom on

originality and creative thinking” can actually benefit students’ synthesis learning experiences (17).

This study’s results also reinforce my observations from a previous iteration of this intervention (iteration #2), specifically the benefits of introducing a long-term intervention like DCMAPs to help students understand synthesis as a *cognitive process*, not just a writing artifact goal. Based on the results from both IRB-based studies, my analysis of students’ mapping-to-writing connections illustrates a *trending toward* continuum of epistemic behaviors of construction. Campbell et al. similarly found that the “relationship between the process of essay writing and the final structure” parallels with the degree to which students adopt a relational and associational conception of knowledge construction (452). My study’s integration of concept mapping—which emphasizes an active construction of knowledge based on students’ enactment of perceived relational concepts—seems to confirm this, and the concept map thus takes on a clearly productive heuristic/hermeneutic role for synthesis learning and practice. As students’ journal entries suggest when they write, for example, that “the material that I constructed in my map allowed me to help write my drafts and journals by allowing me to organize my thoughts” (Student #3), they are practicing not just seeing but *performing* knowledge building as a process of *cognitive* pattern building. The concept map and reflective journal pairing generates observable traces of students’ progress of transfer and translation through scaffolded layers of representation as adaptive growth along “increasing cognitive demands” (Segev-Miller 18).

As a result, analysis of these data seem to suggest that mapping provides a productive interim, interventional step that seems to effectively facilitate moving their schema-building behaviors into writing, as seen in student journals and map-to-essay data triangulation. In contrast, limited or no map work appears to *limit* synthesis efforts and concept assembly to the

first stage of the process continuum (unistructural). Two examples of this limitation stand out among the data: Students 9 and 15. Student #15 exhibited limited participation in the mapping space, as the final map image demonstrates (it contains only four nodes and three connector lines without labeling) in Figure 27 below. Parallel to this is the student's lack of journal activity and a final essay (a portion of which is included with the map image in Figure 27) that is limited to basic unistructural development and lacking source incorporation.

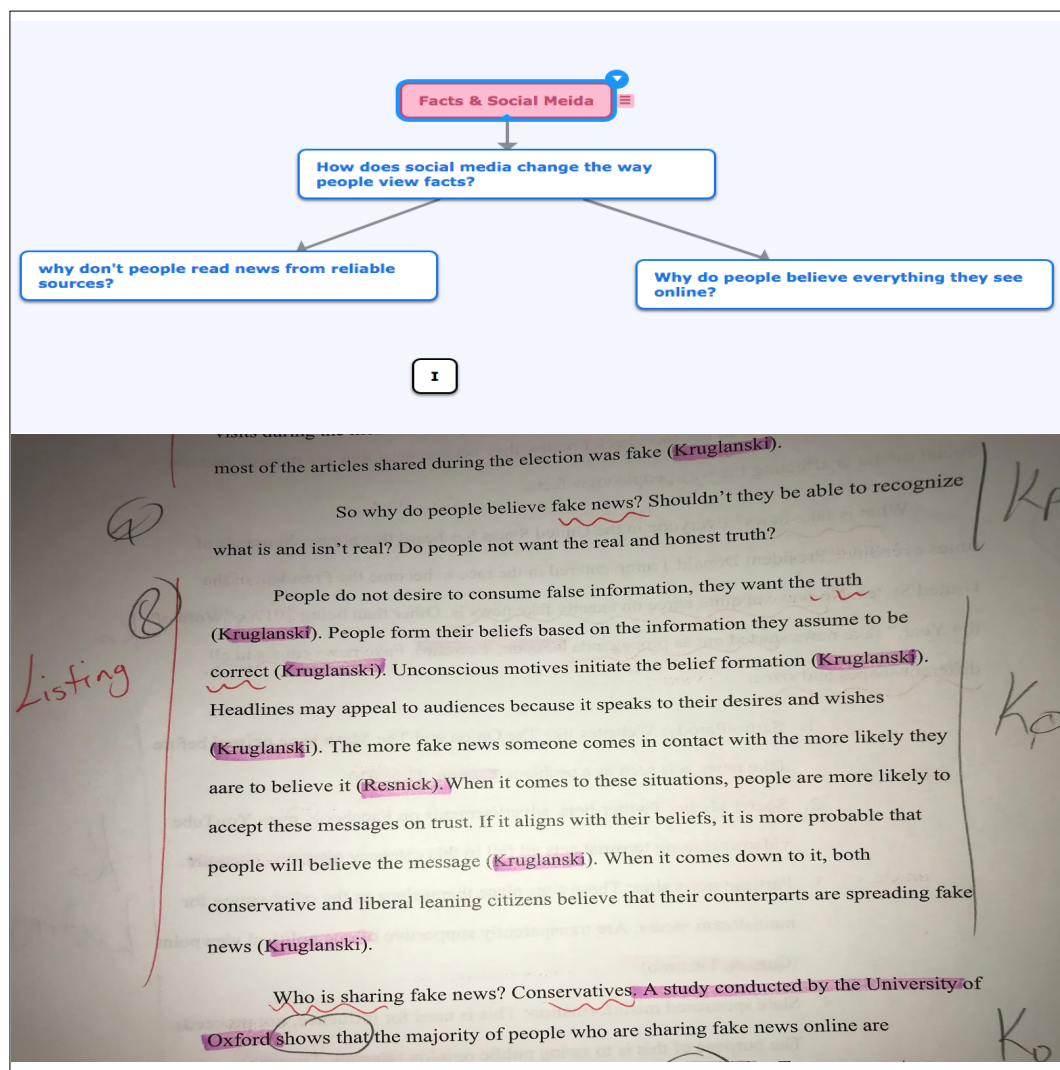


Figure 27: Student #15 Final Map and Coded Essay Sample Illustrating Limited Engagement

While the student’s journal entries offered explanation for her lack of engagement with the DCMAP as due to inexperience with technologies (a cue of prior knowledge), this is offset by other areas of negative participation: specifically, all non-technology writing practices (journals, drafts). This seems to suggest the DCMAP itself may not have been a primary factor in the students’ negative results.

The second student exception is Student #9. Like Student #15, this student used the mapping space in very limited ways (only 19 nodes, many disconnected), with very little incorporation (using 8 simple connector lines without labeling); this patterning was replicated in the unstructural nature of the student’s final essay as well. Neither exhibits any advances in incorporation or D&R, relying on simple listing in both the map and the essay. See Figures 28a and 28b below for a comparison.

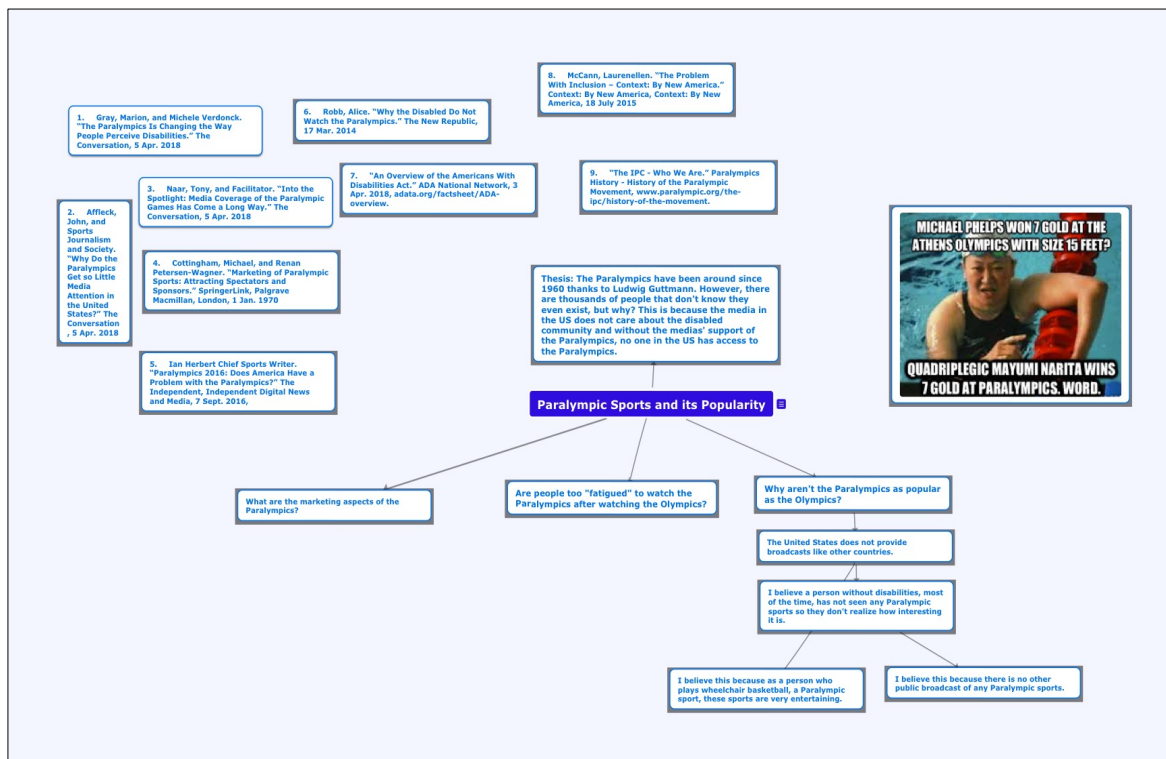


Figure 28a: Student #9 Final Map Illustrating Pattern of Minimal Incorporation, as Corresponds to Final Essay

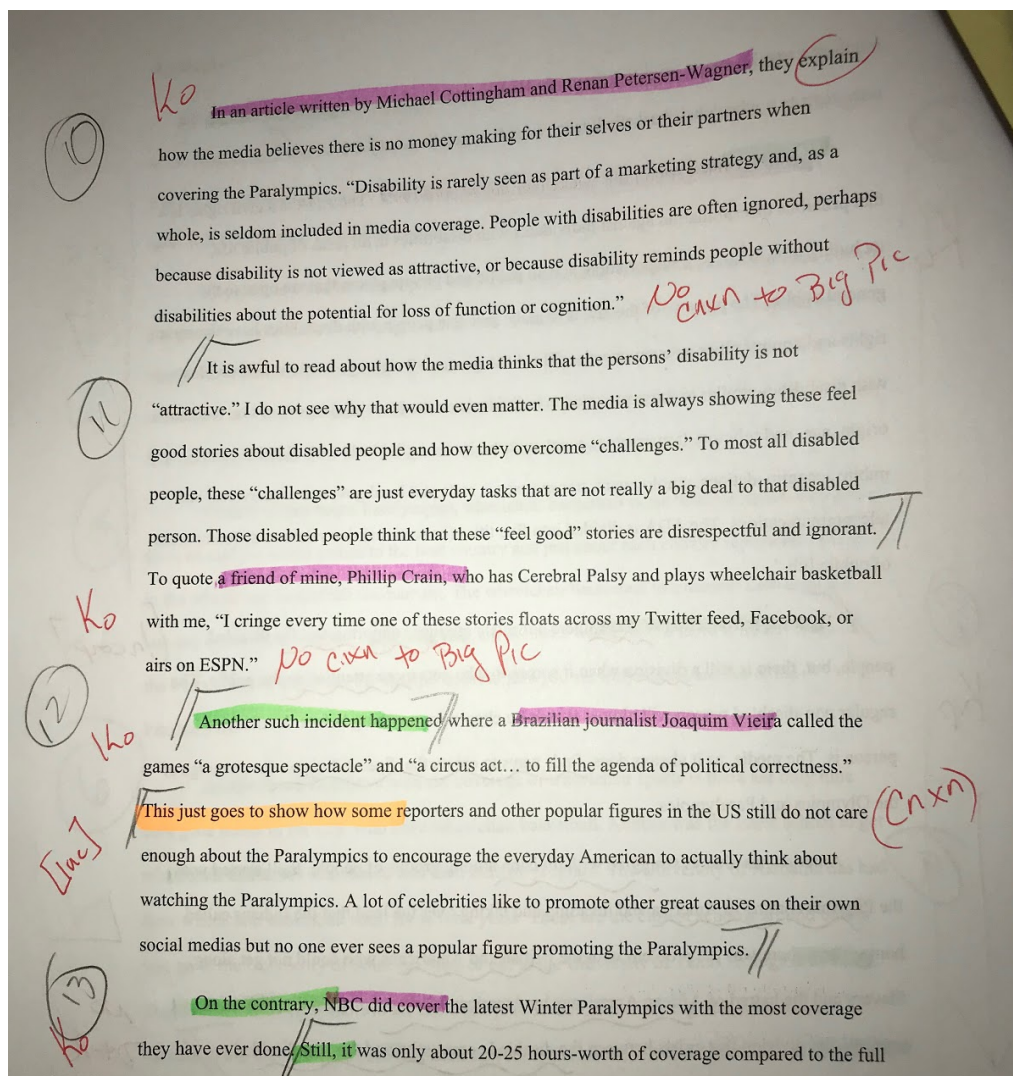


Figure 28b: Student #9 Final Essay Excerpt Illustrating Pattern of Minimal Incorporation, as Corresponds to Final Map

In contrast to the limited journals of Student #15, however, Student #9 did make an attempt to reflect on his map use in connection with his writing and thinking development. His comments suggest that he has engaged with the inventional premise of the DCMAP space ("They are great ways for a writer to figure out exactly what they want to write about"), as well as the role of visualization on recognizing emerging patterns and organization of ideas ("Once the main idea is on the map, the writer can start creating bubbles around the main idea that

correlate to the main idea”). Interestingly, the student explains his difficulty with the DCMAP space in terms of translating thinking into textual form (“I know what I want to say but I have a hard time putting it into words”) rather than visual graphic representations. When combined with the assertion that he is “not a very artistic and organized person,” these comments may suggest that the student may have needed more in-class, explicit instruction on the cognitive potential of a metaphoric heuristic. This observation appears to be reinforced by the student’s final journal entry, at the end of the term, in which he writes, “I would like to continue learning how to use Mindomo and learn more features to help me better express my thoughts and ideas.”

In sum, it is the *possibility* for new discovery (indicated by such student expressions recorded in journals as “seeing how it connected” or “putting ideas together”) that, when framed as an act of scaffolded learning, promotes and facilitates the active forming of links between existing and new knowledge to *visually* integrate materials in an overt, generative behavior of “knowledge construction, not reproduction” (Jonassen and Reeves 695). These observations would seem to support the conclusion that students’ epistemic abilities and development may indeed be enhanced by reflective concept map intervention.

Research Question #2: Conceptualization & Visualization

Question: “*What role might D-CMAPs as visual representation of student connections and knowledge conceptualization play in promoting active and progressive transformation of ideas?*”

The question at hand is whether an intervention of mapping—designed to enact creation of, or mirror existing mental schema—might contribute in some observable way to students’ epistemic abilities: in particular, the conceptualizing and meaning making behaviors associated with the type of transformative construction of new knowledge associated with synthesis. In

other words, my second research question asks whether students are visually representing connections as a *knowledge conceptualization* behavior. Beginning with pre-questionnaires, results from the study indicate just how difficult a cognitive and generative activity conceptualization is. This is not surprising, but trends observed in both questionnaire data as well as comments in student journaling also seem to suggest this difficulty may be—at least in part—the result of an instructional gap in students’ previous classroom experience with synthesis (prior knowledge). The need to bridge the gap from high school to college writing comes with the need to create ways for students to *make* the epistemological leap that is inherent in conceptualizing synthesis (Petrie and Oshlag; Ambrose et al.; Lakoff and Johnson).

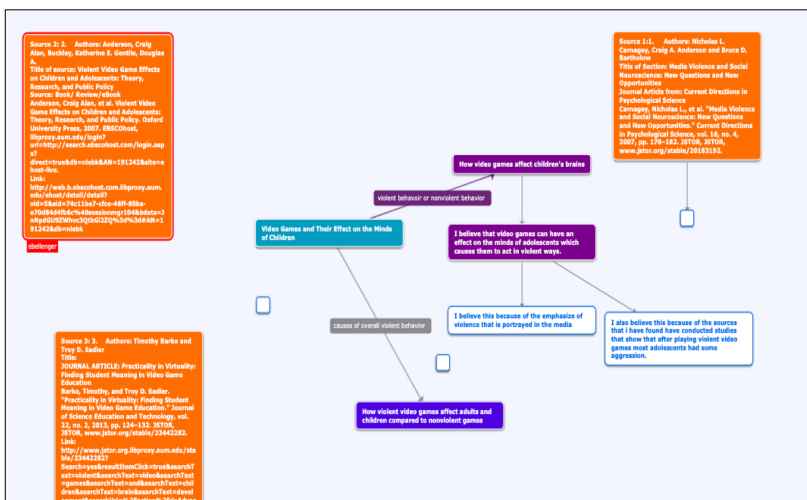
When concept maps are used as a bridge to operationalize this leap, students’ cognitive and graphical performance of visualizing connections provides observable markers or traces of conceptualization as students are recording active *meaning-making* choices to *create* new patterns. For example, most students (from both Intervention as well as Control groups) responded in the affirmative to questions (especially pre-question #11) about their views of visual tools’ impact on conceptualizing, indicating CMAPs played some role in this leap. The range of synthesis strategies—as defined by the Master Code List—observed across data sets also provides a view of process progression in terms of structural and cognitive markers. The moves from early to more advanced synthesis practices suggest a pattern of evolution from early Listing and Combining knowledge strategies (KC) or Developing (KD), to more cognitively demanding Deconstruction/Reconstruction (D&R or KN) on the Continuum range. Early synthesis efforts included reflective elements to capture cognitive and structural signs of constructive decision making (the *why* of students’ creating). The data suggests relationship-

building was emerging as a cognitive act of invention (pre-synthesis complex patterning beyond simple similarity/dissimilarity connections).

At the semester's midpoint, the representation affordances of map designing (color use, connector lines, etc.) have been in active use for more than half of the students' process work. From *Unistructural* to *Multistructural* to *Relational* moves, the recursive nature of Intervention instruction and corresponding student work in both maps and text appears to have had some effect on development of synthesis practices. For example, of the four students (#s 1, 2, 3, and 12) referred to in the Results section concerned with developmental trends along the Master Continuum (see Figures 15-17 and 23 for examples), all appear to show evolving development of both structuring and restructuring through the spectrum of the Continuum. Still, any definitive conclusions are hindered by less-than-optimal student participation (as discussed in the Results and Limitations sections). Thus, any trends of correlation, however suggestive, cannot be confidently attributed solely to map use using this one data point. However, other data groups examined *do* suggest that visual meta-reflection, when combined with intertextual writing (synthesis) practices, promotes the higher level of cognitive awareness and agency essential to knowledge transforming versus knowledge reporting.

In view of these apparent trends in student construction (maps and drafts of text) progressing through the Continuum range of the Master Code List, visualization does appear to promote at least some degree of metacognitive reasoning, creating concrete opportunities and sites where students' explicit reflection on ways their mapping's cognitive representation functions track from early Structural toward later Generative. This is seen most clearly in mapping journals NP1-NP3, which focused on correlating mapping process explication and meaning-making efforts. Of these four, Student #3 provides one of the more detailed examples of

this progression within both her map design and reflections, as well as in her final essay, moving from early Unistructural into later Multistructural (combined with some Relational) characteristics. Figures 29 through 31a-c provide a snapshot view of this in the form of a series of juxtaposed images between map stages and text passages, in a sequence that demonstrates this progression.

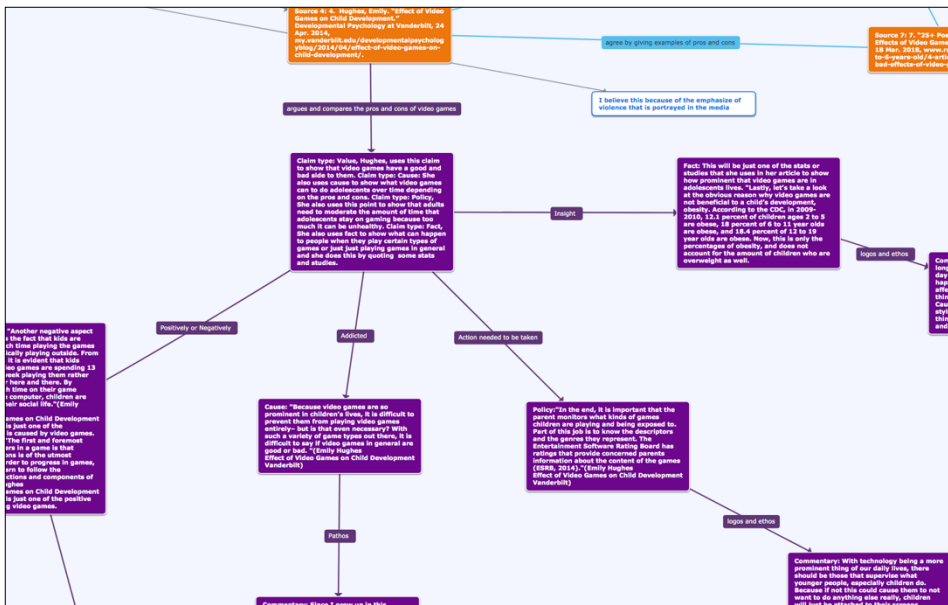


1st narrated map, indicates basic content and rhetorical goals (narration transcript is below).

So the topic that I'm doing for this semester is how violent video games affect the minds of children. For the area here on the right I have four sources that I'm going to use to help me. And the main topic that I did for this side is that I believe that violent video games affect children's Minds. I believe this mainly because of what they're exposed to at home and also in other areas of social media like the internet and Snapchat, Instagram, Etc. And here at the bottom I'm using this is a comparison of how violent video games affect the minds of adults and children and I'm doing this because I want to see how adults and children both interpret different types of video games whether they're violent or non-violent and I believe this because since depending on the age children don't necessarily interpret the games as much cognitively as an adult would so children don't process the games as much as an adult would because their mind isn't as developed and as advanced as an adult so like a violent video game they might not be able to process everything as much as an adult as the adult's Minds more developed as the child so this is what I'm wanting to research here and that as a result is what I believe would be what

Basic content
 layout, reasoning for content
 Rhetorical Goal
 Kp "want to see"
 "want to see" research

Figure 29: Student #3 Map to Text Progression, Early



2nd narrated map begins to incorporate more of the early connecting and generating practices.

argues and compares the pros and cons of video games, one of them being value about four of the different claim types basically like the good and bad parts of video games. causes like what causes them or become really addicted to them. policy like what should be done to like in moderation for kids or just anybody in general not to stay on them for so long and fact of like some of the things that they do to us in General. so for the first section I talked about for value I said for the little arrow just basically the positivity and negativity of it and then I give two quotes of like some positive and negative aspects of it which I then use pathos which basically I was saying from there for the four values is that this area can be controversial because of it's just different things on this planet that we have a lot of things are controversial it just depends on what we believe in the end. for the next one for cause I said addictive which basically a quote that I took from an article of Hughes was basically saying that people from this current generation, I myself included, are addicted to things like this video game since it was a part of what we had growing up. and I use pathos as well here because I was saying that since you know with the current generation since video games have only been around like 20 or 30 something years it's something that as kids that have been born just in that time period are used to and we like to do it a lot. but still I will admit that I've been addicted to videogames myself but at the same time growing up I have realized it we should do it in moderation and that's what I put for my policy area basically I just talked about what the parents should do and all. and I think I put Logos and Ethos was basically saying that parents need to moderate with their kids look at it because if not their children just any adolescents are just going to be glued to their screen and not want to interact with anybody and then plus who knows what else, that could affect them, how it could affect like their attitude at all. and then for fact I said insight and basically gave one example like some spats at the I think it was the CBC did a few years ago from what she basically was saying depending on adolescents of different ages depending on how long they spend on video games can affect like their overall health one of those being obesity because of how long they're sitting down and like playing the games and what not. and from there ... I don't remember exactly what I put in the arrow from my comment I

MM
MM
MM
MM
MM
MM
KoS
CDC

Figure 30: Student #3 Map to Text Progression, Middle

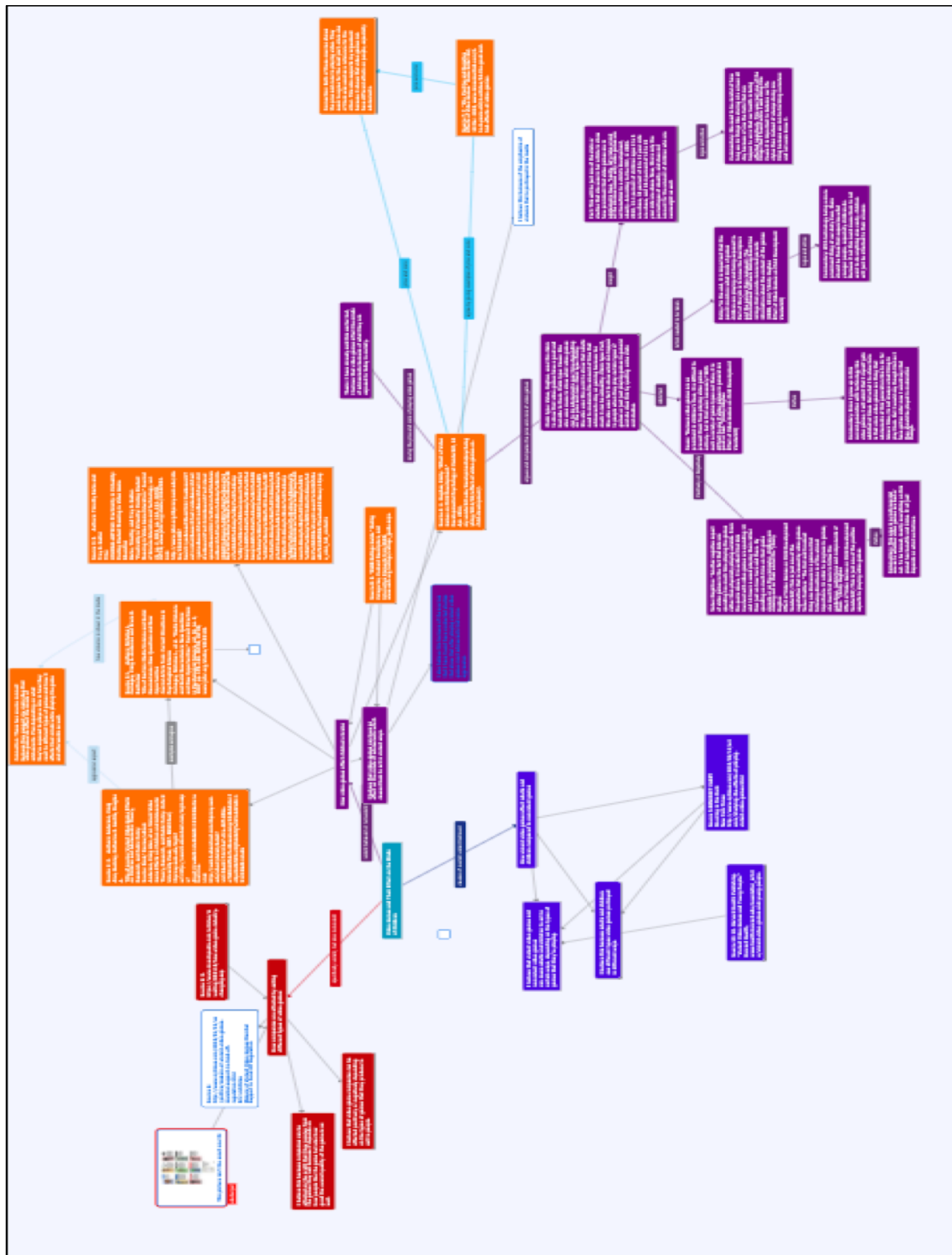


Figure 31a: Student #3 Map to Text Progression, Final

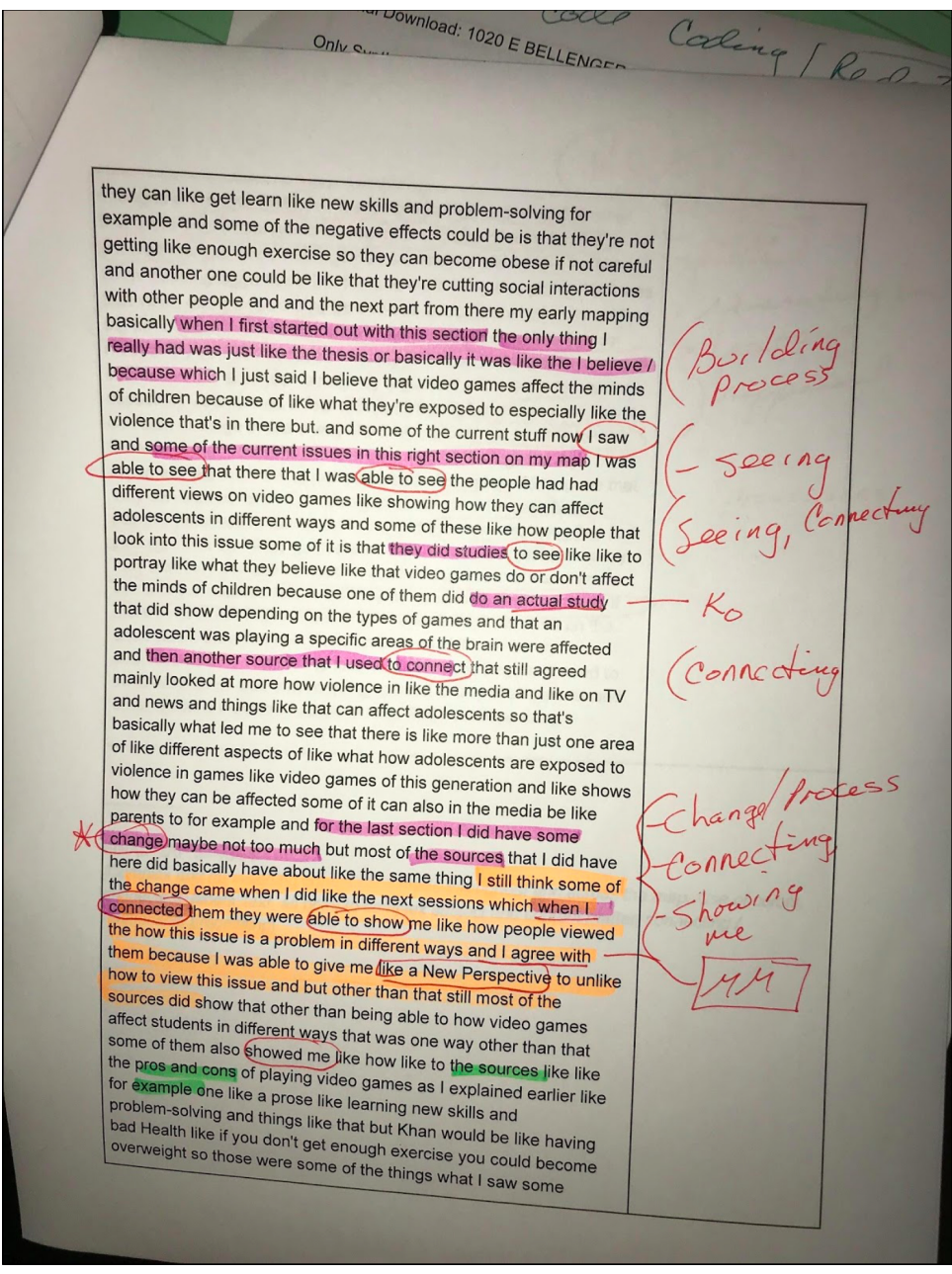


Figure 31b: Student #3 Map to Text Progression, Final Journal Entry on Mapping

This student’s final map of the semester contains visible complex and multiple connective directions between nodes in multidirectional patterns, demonstrating incorporating, generating, and associating. The passages in student’s narration contain more generating and discovery, as

well as connecting language. The content of the student's final essay excerpt (Figure 31c), demonstrates characteristics coded for Multistructural and Relational elements, as well as early transforming (D&R, Meaning Making).

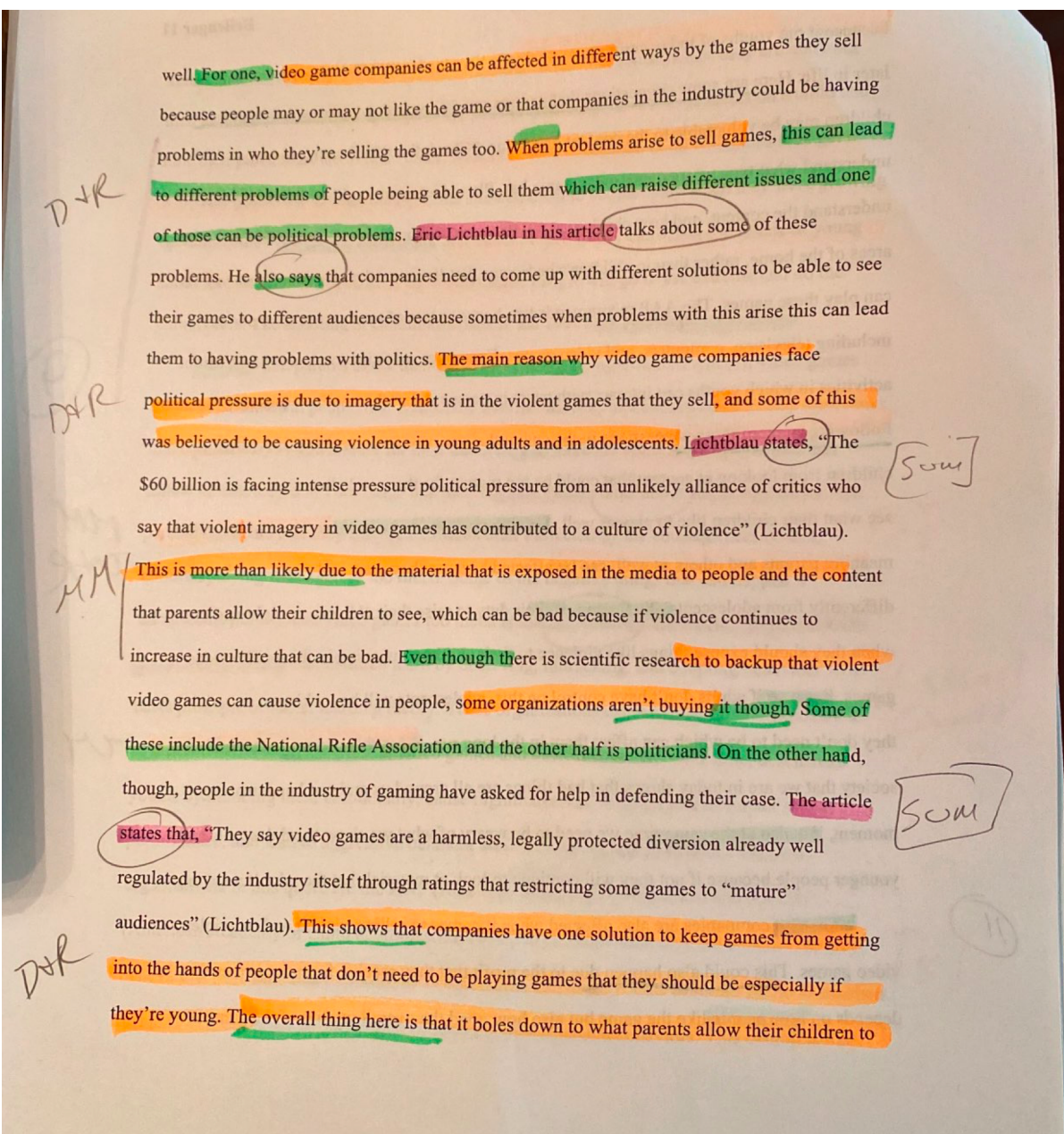


Figure 31c: Student #3 Map to Text Progression, Excerpt from Final Coded Essay

Thus, examining individual student progress through each data set seems to suggest there *is* a connection between visualization and conceptualization (at least, according to student voices as represented in their NP journaling). In contrast, Control group artifacts offer text-only strategies, which demonstrate fewer meaning-making examples of conceptualization. Due to the small sampling size, however, it is difficult to tell if this limited the success of student synthesis efforts.

This is a significant result for my study; as mentioned in the previous chapter, an underlying premise for this design-based research is concerned with how students are *learning* to conceptualize. Because conceptualizing can be explained in cognitive terms—i.e., pattern identification and construction—the responses to pre-questions related to this practice again suggest a level of uncertainty or inexperience. Both the Intervention and Control groups’ responses to Question 8 of the pre-questionnaire, for example, indicate a confidence in pattern *detection* but *not* pattern *creation*, especially when conceptual-level agency-based meaning making is involved. For students in the Intervention group, this is vital to interpreting students’ concept mapping as an active learning process in terms of Patterning Theory’s role in constructivist theories (Boscolo et al.; Bruillard and Baron; Campbell et al.). As neuroeducation scholar Judy Willis explains, “[o]ur brains perceive and generate patterns and use these patterned networks to predict the correct response to new stimuli. Patterning refers to the meaningful organization and categorization of information” (59). Integrating scaffolded learning opportunities to overtly engage in such pattern building appears to give students time to practice this cognitive step in a very visible, performative space of critical reflection in order to address this epistemological “gap” (Petrie and Oshlag 583). Control students, on the other hand, have only textual processing to assist them make such a cognitively complex maneuver and—despite

the small sampling—these results do appear to show the limits of this approach given that only 1 of 5 control students’ essays exhibit KD or KN. Further, structural patterns of map construction seem to carry over to *essay* construction as well, perhaps another trace that can be read through the prism of conceptualization. For example, as illustrated in Table 21 below, students like #9 and #10, whose maps contained limited or unistructural listing rather than complex incorporation, contained fewer nodes and links than those students like #3 and #14 whose maps and essays both demonstrated multistructural-to-relational levels of development.

| | Student #9 | Student #10 | Student #3 | Student #14 ⁵⁵ |
|----------------------|------------|-------------|------------|---------------------------|
| # of Nodes Connected | 9 | 16 | 34 | >35 |
| # of Connectors | 8 | 15 | >30 | >30 |
| # of Labels | 0 | 5 | 19 | <5* |
| # of Isolated Nodes | 10 | 9 | 0 | 10* |

Table 21: Node and Connector Count Comparison Among Intervention Students to Illustrate Possible Trends in Pattern Building

Further, those students whose maps followed a more linear, simple hierarchy of one-deep, one-directional associations and relations appear to mirror this level of cognitive construction in the structure of their final essay synthesis efforts, and more often (like the Control samples) used simple additive terms like *proof* or *support* to integrate source ideas within their own argument structures. These results suggest there is an apparent correlation

⁵⁵ It is worth noting here that Student #14 adapted the default affordances of the DCMAP in unusual and creative ways, unlike many of her peers. The low count of label use (<5*) is offset by the fact that she adapted nodes and text to provide the connective content. She also explicitly explained her reasoning for creating isolated patches of nodes (10*) to suit a specific rhetorical function suited to her “thinking for stage 3” (an outline). Her final journal post on design choices indicate she “broke [her] thinking up into sections that each cover a subtopic” of her essay, creating “branches” that each contain circle-shaped nodes to represent categories.

between students' map-construction efforts (i.e., developing patterns and "chunking" designs) and their essay construction when moving beyond simple linking and summary into incorporation and more complex levels of multistructural development.

Another area where visualization and conceptualization emerge as data patterns is the apparent trend that the less time and effort students spent on reflection to make explicit cognitive connections to their constructive efforts in maps, the more they relied on basic Assembly/Listing/Summary construction practices in their synthesis texts. This seems to correspond to research into mental schema; Bruillard and Baron observe that schema *building* is "fundamental to the way we understand all experience" (331). Designing maps, then, appears to contribute to mental schema building as a form of enacted cognition (Hutchins). When students are asked to actively *change* their representations of knowledge (such as moving from familiar patterns of paragraph building or reading to write into a visual mapping), they are also engaged in *translating* their "task representation," a cognitive move mentioned by transfer theorists in our field as well as in cognitive sciences; this is a move that must happen whenever conceptualization is taking place. As Schumacher and Nash observe in "Conceptualizing and Measuring Knowledge Change Due to Writing," it is this "modification of previously acquired information" that is the marker of change or learning (73). The importance of this "creation and the translation of . . . alternative mental representations of meaning" (Flower and Hayes "Images" 122) to learning complex conceptual practices like synthesis has been reinforced in recent years in writing research by such education scholars like Battaglia and Boscolo et al., whose studies of synthesis behaviors have informed this study's intervention design.

Translation & Transfer

Based on the patterns emerging from these results, it seems apparent that map design affordances *do* impact meaning-making efforts when used for knowledge representation and constructed connections that are subsequently *translated* in students' journal reflections. While journals and maps from the Intervention group appear to demonstrate signs that such development is taking place in terms of metacognitive-level reflection, the challenge is whether this advances to transform, translate, and transfer into writing passages. As illustrated in the Figures and Tables provided earlier, results from the Intervention group's data suggest more pattern building is occurring over time. Student comments attribute this to the ways active and progressive engagement in mapping allows them to see patterns or discover new connections, which they then transfer into their writing. For example, as I observed in the Results chapter, in the concluding weeks of writing their essays, students were asked to reflect on the how and why of their map construction reasoning as it related to their synthesis efforts. The results appear to suggest a clear connection between what students did in the map space and what they did in their final essays, in particular as they related to meaning-making as facilitated by map affordances (see Results chapter for more details). Most student comments illustrate a pattern of progression through the conceptualizing continuum represented in the Master Code List, from Assembling/Constructing moves on through to Associating/Generating, and even some signs of early Deconstruction & Reconstruction (D&R), the prelude to Transforming/Restructuring of synthesis.

Student #3 provides the clearest illustration of this and is represented in Table 21 and Figure 32 below. In the final journal assignment, I asked students to comment on what they did in their Early-Middle-Late stages of their mapping, and comment on the "why" of their choices

in terms of their writing goals. This was to be done after reviewing the history playback of their Mindomo map creation process. As indicated in the Results chapter, only a handful of students completed this entry, but Student #3 provides this as well as the optional reflective connections to the essay writing process that captures indicators of translation and transfer. (Prompt language: “How did you take what you built in the Mindomo map and use it to write your journal entries or your drafts? How did you use the mapping activity to acquire NEW knowledge or reshape others’ knowledge to make your argument work?”)

| Excerpts from Final Journal Reflection of Student #3 With Coding Markers in Brackets | |
|---|--|
| [Discovery] | [Sequencing / Structuring / Functional] |
| <ul style="list-style-type: none"> ● [Early] “I further divided that topic into three sub areas that included who I wanted to see who was affected.” ● Sequence of “here I wanted to show” ● [Middle] “I started to add sources to help my reasons out more and the overall use of color that I used in each section to show how I felt about them” ● “I used purple...to show...” ● “I used orange to give a contrast...by showing how important they were and how they allowed me to see...” ● “I used blue to express how depressing...” ● [Last] “Lastly, for the final section, I added a few sources that I hadn’t found when I was in the Middle part of developing my map.” ● “...I was able to use the sources...to help make <u>new connections in my map</u> in being able to <u>see how similar</u> that some of my sources were and how I can use these similarities to help me support my overall argument...” ● “...<u>in seeing</u> these new areas they will allow me to <u>see</u> how there are pros and cons to the things that go on in a major issue.” | <ul style="list-style-type: none"> ● “The first area included... I was mainly wanting to show here in this area of my argument that video games <u>could cause...</u>” ● “...the second area, I wanted to show that different age groups <u>can be affected...</u>” ● “Because here I wanted to show...I wanted to cover how...I mainly talk about...” ● [Middle] “add sources to help my reasons” ● [Last] “added a few sources” ● “Make new connections” ● “three sub areas” ● “support my argument” ● “...make new connections of where I could see different side views in the sub areas of my points that I’m using to help me support my main [argument]” |

Table 22: Excerpts from Final Journal Reflection of Student #3 (Coding Markers in Brackets), Corresponding to Following Figures of Early, Middle, and Late Map Excerpts

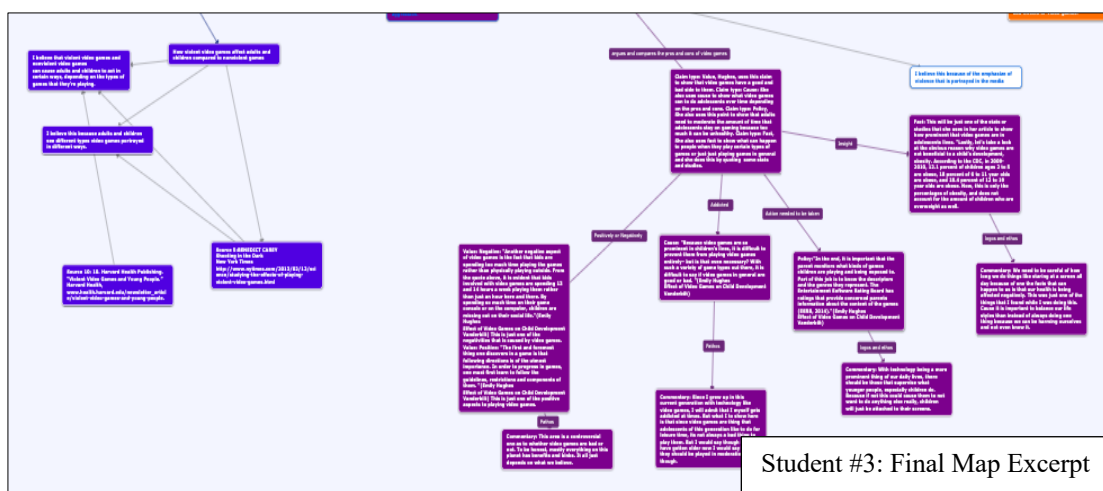
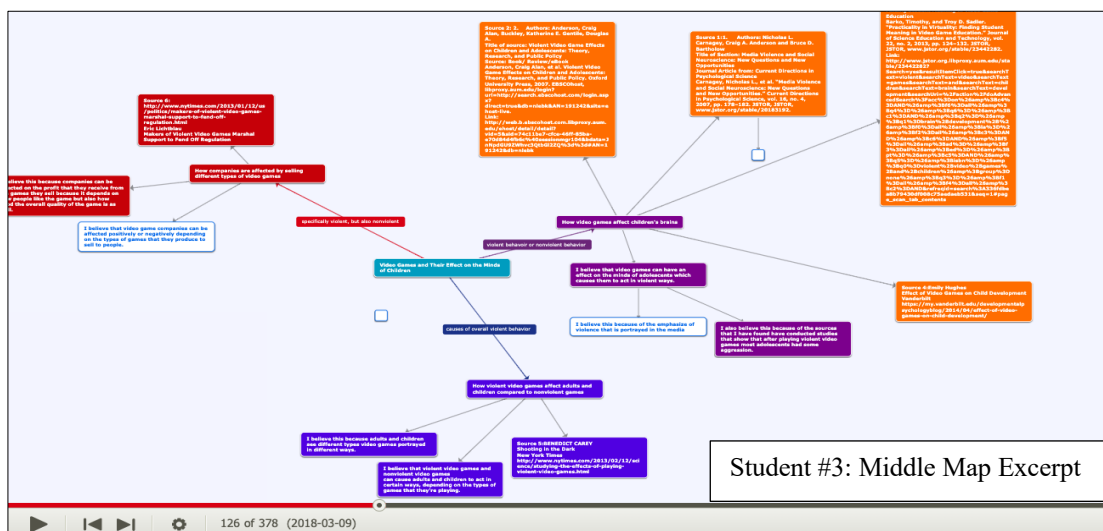
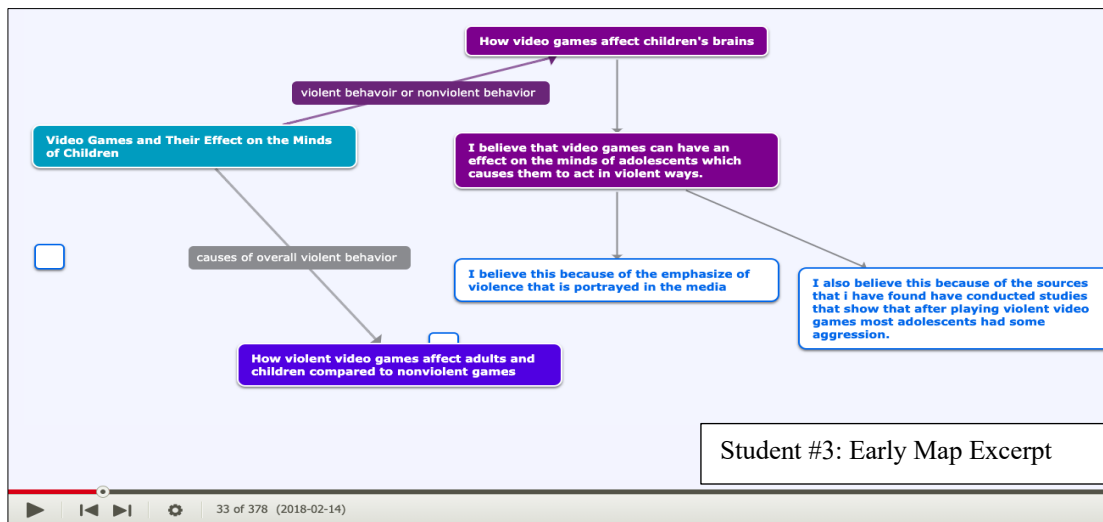


Figure 32: Map Excerpt Reflecting Early, Middle, and Late Map Construction, Illustrating for Comparison to Student #3 Final Journal Reflections Found in Table 22

Additional support for this observation on conceptualization is found when correlated to post-questionnaires #3 and #6, along with final journal reflections on their CMAP experiences. This creative aspect of conceptualizing is certainly the most difficult, especially at the level of abstraction called for by synthesis writing (Campbell et al.). The majority of students who answered these questions agreed that concept mapping helped them identify key concepts and discover new connections, two behaviors of pattern creation at the cognitive level. What is more interesting are the non-negative responses to Q3, that *frequency* of engagement with concept mapping benefitted their efforts to create new knowledge patterns and transformation opportunities. This seems to also affirm the argument that designing learning opportunities when students become actively engaged as *agents* and co-creators/designers of their knowledge- and meaning-making processes appears to have positive impact on students' epistemic and conceptualizing experiences. As discussed in the Literature Review, conceptualization as a cognitive process cannot be successfully learned or taught if limited to framing it as an abstract or unexamined goal, as opposed to a generative *activity* of learning and pedagogy (Jonassen et al.; Campbell et al.; Segev-Miller; Mateos and Solé). These results correspond to trends reported in the other three data sets of the Results chapter, as related to students' concept map use. Such triangulation appears to support the premise of both my first and second Research Questions.

The Control group's data was intended to provide a contrast here, a text-coding approach compared to a dual-coding approach to conceptual learning. In their research on learning and concept mapping, Nesbit and Adesope point to a number of possible ways CMAPs may be more productive as scaffolding spaces than text when it comes to "verbal coding . . . In maps, a concept is represented by a single node regardless of how many relationships it has with other concepts. That is, maps visually integrate propositions dealing with the same concept" (418).

When students apply this in their maps, connections appear more relational as well as associational. However, when nodes only feature source references or identifiers, connections are often lacking. In the case of Control Group text-only representations, however, there exist forms of concepts that Nesbit and Adnesope describe as “represented at several places scattered throughout a text passage, and it may be represented by different words” (418). The visual mapping used by intervention students, however, provides a non-restricted and less linear view of representations for pathmaking possibilities which, as Nesbit and Adnesope point out, “may lower the cognitive load needed to add new associations to those already linked with previously encountered concepts by allowing a more efficient visual search than text passages, a more efficient search of long-term memory, or both” (419). Text-only representations, as linear constructions, do not present such a vista for searching, and therefore may limit student discovery and invention.

Conceptual Transforming: From Maps to Essay Writing

When making the transition to essay writing, however, results appear to show some inconsistencies in this pattern. This may be due, in part at least, to student experience as *agents* of knowledge construction (early levels of the Master Code List process continuum) or as *agents* of knowledge generation and transformation (later levels). Translating such knowledge visualization into text—especially in an academic essay—is likely a novel constructive exercise for most students, yet because this study’s focus is on the epistemological *processes* of knowledge construction, these results are still suggestive of a positive correlation. The results of this continuum process of synthesis learning, from students’ reflection on their use of concept maps to visualize concepts as opposed to relying only on text processing, is explained by Nesbit and Adnesope: “The act of translating information from a text format to a node-link format may

require that learners process meaning more deeply than they normally do when reading text or listening to a lecture” (419). This is one reason why maps are recursively combined with guided reflection opportunities in my study design.

These researchers go on to explain that “learners benefit from receiving information in a text format and converting it to a map format, or vice versa . . . because in doing so they must make decisions about information structure that is latent in the text” (Nesbit and Adesope 419). I see this happening in student map construction as well as in their reflections on design. Results suggest that students often “see” new relationships through mapping, a result that may be due, at least in part, to the flexibility of structure. This may also be due to the informal nature of conceptualizing via images, which, as Nesbit and Adesope point out, “encourage[s] a range of deep learning strategies that depart from the surface strategy of repeated reading” because “[t]he act of judging concept importance requires deeper processing than the student might normally exercise when reading text” (420). Yet while textual schema like outlines are widely relied upon in writing classrooms like the Control groups, *mental* schema construction is not as common to our instructional toolkits when it comes to teaching synthesis, despite research that promotes the benefits of explicit teaching for transfer. In his research into visualization and academic writing, Battaglia asserts that visual representations may actually “be better at expressing certain kinds of meaning than prose would be,” although admitting that “some will be more difficult to translate into prose than others’ (122). This is certainly evident in the range of responses illustrated by the student-generated data of this study.

My analysis of students’ map-to-essay correspondence suggests two patterns emerging from students’ data, interpreted in terms of progression along the Master Coding Process Continuum:

1. Pattern 1: student journals that suggest either (1) prior experience with visualization or mapping as part of their writing process (invention) or (2) confidence in or demonstrated experience in their synthesis abilities *corresponds* to apparent engagement in the purpose of the map and its connection to writing, coded as evidence as KD and KN.
2. Pattern 2: students' translations of their mapping into final essay (synthesis) writing appear to suggest clear categories along knowledge transforming stages.

The same six categories of the Continuum Process that appeared in this chapter's earlier discussion of journal-map correlations (section Research Question #1) appear again to *correspond* to transference of knowledge behaviors between mapping and the final synthesis writing artifact examined (final essay). Villalon and Calvo's research into concept map and visualization explains this correspondence this way: "Cognitive Visualizations provide . . . feedback [to the writer] because they make the author's thinking visible, making explicit the mental model learners are using" or, I believe, creating (23). While journal prompts were designed to create such a "visibility space" to help students develop the types of personalized "metaconceptual scaffolds" mentioned by Villalon and Calvo (23), the translation (or epistemological leap) from informal visualized conceptualization into essay-based conceptualization is the final step of this continuum process under study. The results from both Control and Intervention groups demonstrate rather interesting patterns in their parallelism, as illustrated in Table 22. While allowing for the previously mentioned limitations of data gleaned from the Control group, there are three general conclusions that emerge from comparing these patterns of correspondence.

1. There appears to be a parallelism in behaviors based on the 6 categories of Continuum Process between Control and Intervention results.

2. The more the process work exhibits the Associating/Generating levels of concept building, the more likely the essay synthesis will also demonstrate Associating/Generating.
3. Likewise, when there is limited Incorporating present in prewriting process work (both written and mapping), this corresponds to a unistructural essay synthesis.

| | INTERVENTION n=15 | CONTROL n=5 |
|---|---------------------------------|--------------------|
| 1. A complex map design/prework (KD, or multi- or relational-structural) but final text-based essay was markedly less so, more unistructural (KC) | Student #s 4 & 12 | |
| 2. A simple map design/prework (KC) corresponds to simple unistructural essay (KC) | Student #s 2, 8, 9, 10, & 15 | C1.2, C1.3, & C2.2 |
| 3. A complex map design/prework (KN) translates into mapping-related Journal entries representing students' multistructural or relational thinking, but does not similarly translate into the written essay (KC or KD) | Student #s 1 & 11 (emerging) | |
| 4. A complex map design/prework mirrors to complex multistructural or relational written essay (KC+KD, KN) | Student #s 3, 5, 7, 13, & 14 | C1.1 & C2.1 |
| 5. Negative mirroring: absences of concept and knowledge building in one corresponded to the same absences in the other. | none | none |
| Outlier: simple map/prework but complex essay | Student # 6 | none |

Table 23: Comparison of Pattern Generalizations, Intervention vs. Control

Of the student samples drawn from Intervention Map-to-Essay comparison (n=15), the majority (10 of 15) fall into categories of direct parallelism: either simple-simple or complex-complex. Five samples demonstrate complex mapping corresponding to complex (multistructural to relational) essay synthesis (KN or KD), reaching the Associating/Generating and even early signs of Transforming/Restructuring in both maps and essay. A corresponding number (5 of 15) demonstrates simple mapping corresponding to simple, unistructural essay synthesis (KC),

reaching only the level of Connecting/Linking on the Continuum scale. Of the remaining 5 students, their results included noteworthy variables such as lack of reflective NP1-3 journaling (2 students), or overall lack of engagement in the process (1 student). Finally, two students were marked as “emergent” along the Complex-to-Complex range, in that while their final essays did not demonstrate the same degree of complexity as their maps and journals, there were signs of emerging behaviors. This may reflect a conceptualization difficulty in translating (or re-coding) visual representations into written representations of knowledge, as discussed earlier.

The Question of Translation

A pivotal question here is whether students are able to perceive what they do in their map spaces as *performing* synthesis, with the potential to be mirrored to performance in their writing. Such meta-awareness would certainly be needed to carry over the map constructive moves (both cognitive and structural) to their written synthesis performance in the final essays. Would data from student journals, along with generalizations based on trends in questionnaire responses, reinforce any indications of epistemological agency? The degree to which data suggests knowledge telling versus knowledge transforming may be one way to answer these questions. As pointed out in the Results, Intervention student responses to post-questionnaires on the subject of patterning (Questions 1, 4, 5, and 7) provide one such form of data. Students-as-designers’ efforts to create intra- and inter-textual connections by using the “various affordances of different modes of meaning-making” (Comber and Nixon 221)—including both the visual and the cognitive in concept mapping—signal observable, traceable markers of potential transforming (Barzilai et al.; Mateos and Solé; Segev-Miller; Boscolo et al.). More than half of respondents to these four questions agree that connective relationship building in their maps impacted their cognitive and writing processes. This suggests the concept map is a site where

potentially positive “epistemological leaping” might be taking place. Mateos and Solé’s research points to the significance of this, in that it is “during the connecting process [that students] . . . integrate the contents from the different sources with their prior knowledge, which may lead to a more or less substantial transformation of the contents” (436). Further, the student journaling and final essays provide a process-based sense of what behaviors develop and transfer. Here again, the Continuum used for second-pass coding provides the traceable markers: [KC, KD, KN] along with their correlation to knowledge transforming stages.

The “epistemological leap” (Petrie and Oshlag 583) required for full synthesis as cognitively-based knowledge *invention* would most likely appear in students’ final synthesis reflections and writing focused on “why,” not just structural, connections. Here again, triangulation across the four data sets offers a view of a continuum-based process that seems to offer a sense of how students are making such leaps via the intervention’s design. The apparent relationship between students’ imagery efforts, reflective connections and explanations drawn from journals and questionnaires, and final writing passages are presented along a continuum based on complexity of structure that may reflect their views of knowledge. As Campbell et al. write, this sequence of unistructural to multistructural to relational may represent a progressive understanding of epistemologies related to synthesis writing, “from a simplistic view of knowledge as being absolute and imparted by authorities, to a more sophisticated understanding of the complexity of different knowledge claims, and the need to construct personal interpretations based on evidence and analytic reasoning” (450). This appears to be supported by my results. The student essays coded as *unistructural* (integrating only one source in synthesis but leaving out the creative interpretations of student voice) corresponded to simplistic map structures that predominantly used Listing as structural choices. These essay samples also

corresponded to limited map engagement, such as in a lack of reflective process work in the NP1-NP3 postmapping journals designed to facilitate translation. Essays coded as *multistructural*, represented by heavy reliance on Listing and Summarizing and simplistic Incorporating, correspond to mapping visualization that demonstrates similar moves. The final category, *relational*, appears less frequently among the results, although Intervention students who constructed complex maps that integrated relational vocabulary or connector use, like Student #3, also demonstrated relational passages in writing. When compared to the Control group's text-only samples, there appears to be similar parallelism in structure, from unistructural to multistructural. There were no Control essays coded as Relational, which may be significant enough to study further in future iterations of this design.

Do these results suggest concept mapping—when coordinated in this way—helps students adopt a cognitively generative approach to synthesis as they practice structuring knowledge? To answer this question, I looked at the data quadrants for markers of generative practices: patterns of vocabulary use that carries over from one data form to another, examples of translation of mapping design features into meaning-making writing strategies, and transfer of design and/or reflection on design into written synthesis structures. Data gathered as a result of incorporating multiple layers and spaces for reflection provides for moments of what Barzilai and Zohar call “epistemic metacognition” (41). Their definition of this term draws from work by Kuhn, who explains that epistemic metacognition is defined as “how individuals *conceptualize knowledge and knowing* as they engage in cognitive tasks” (Barzilai and Zohar 41; emphasis added). As situated in this study, concept mapping is designed to serve as such a constructive “cognitive task,” in that student agency guides design and development of representational choices to generate maps of their knowledge construction. Interestingly, the student journals

marked as Unistructural (like Students 9 and 15) are rather revealing, as discussed earlier. Even though the final process stage of student essays do not uniformly rise to the fullest levels of the Transforming/Restructuring Continuum, the focus of this intervention is on helping students *develop* strategies for knowledge conceptualization required for successful synthesis writing. With this in mind, the study's results appear to suggest this intervention's design was successful in that it "allow[s] learners to develop an awareness of their own mental representations and inferential processes" (Villalon and Calvo 23), through students' map development processes and as reinforced by corresponding reflective journals.

Research Question #3: MBE Influences, Assignment Design, & Synthesis Instruction

Question: *"Can MBE scholarship and theories, when combined with an understanding of Visualization as a cognitive process, productively inform assignment design for synthesis and research writing in the first-year writing classroom?"*

Spivey and King's study of synthesis defined it as a "goal-directed activity of reading in order to write" (5). The type of goal targeted by our teaching pedagogy is important to my discussion of my third research question. As the premise of my study asserts, synthesis taught as a goal-directed activity does not guarantee the *level* of complex critical thinking needed to create new knowledge. Indeed, as Campbell et al. remark, "little research has investigated either the nature of student learning and understanding which occurs through essay writing . . . or the student strategies which lead to success" (449). One of the core assumptions for my study is that when synthesis is taught—and subsequently conceptualized by students—as a rhetorical *product*, this often fails to achieve desired results; however, teaching synthesis as a *process* of invention may lead to deeper cognitive engagement and more complex conceptual construction practices. As Segev-Miller's research found, "differences in motivation resulted in different goals and the

use of different strategies, especially when coping with demanding tasks” (“Writing” 7). In other words, if students represent the task by framing themselves as knowledge designers, this may contribute to an approach to synthesis as invention. Segev-Miller further concludes that students “who adopted *product goals* used ‘surface-level strategies’; those who adopted *process goals*, on the other hand, engaged in more significant processing of the information, were more persistent and reflective, and used effective cognitive and especially metacognitive strategies” (8; emphasis added). My final research question asks if students are led to see synthesis as a cognitive process of inquiry and invention (that is, our pedagogy and materials frame it and scaffold it that way), are there changes in how students write?

Analyzing the student map/journal/essay combinations from the Results chapter appears to demonstrate the instructional design benefit of what Winslow and Shaw call “enlist[ing] students as ‘co-investigators’ of their own metacognition and agency” (205). Because making learning visible through active concept map construction (Hay et al.) depends on active student exploration of their own ongoing metacognitive efforts (part of the map artifact), integrating this into pedagogical practice requires explicit instruction on “how to” make this leap. An example of this is demonstrated by students like #9 and #15, whose lack of engagement with both journaling and mapping may have been a factor in their final unistructural essay work, as is suggested by their final journal comments: “My . . . map is not very big because, obviously, I didn’t use it too much” (Student #15) or “Mindomo has been difficult to me because I know what I want to say but I have a hard time putting it into words” (Student #9). Winslow and Shaw observe that “[m]etacognition is hard to recognize and assess” (206), but when assignment design overtly integrates students’ intentional and reflective construction through visualization of the

knowledge creation cycle, as this study does, markers of its impact are certainly created and observable, even in its absence.

For example, teaching students to juxtapose their map construction and corresponding reflection practices provides what Bruillard and Baron call an “intermediary solution between drawing and language production, since they do not force the representation to be as linear as language production would do” (332). In doing so, mapping also addresses one of the key concerns of teaching for transfer: “how the mental model of writing students develop—or don’t develop—can affect how they approach writing tasks” (Yancey et al. 41). As the results from student journals suggest, mapping engages students’ agency “in deciding where to go and how, at least in terms of seeing possibilities and how they relate to each other—precisely because one can see relationships *across* locations” (Yancey et al. 41). Sousa discusses this in terms of “association,” which he defines simply as “[w]henver two events, actions, or feelings are learned together, they are said to be associated, or bonded, so that the recall of one prompts the spontaneous recall of the other” (153). Framing recall as cognitive invention would align with the epistemological potential created when map construction transfers over to students’ synthesis writing efforts by virtue of the *associational* and *relational* affordances of the CMAP connection and labeling functions. The degree to which these students are able to readily perceive these pathways is illustrated by map connector building and reflective comments that integrate terms of construction (“I had connected my thoughts to each of the sources,” Student #8 NP3) and perceived relations (“I developed it to show,” Student #3 NP3). (Figure 33 below shows the corresponding map narration submissions for each student.)

Student 3 NP3 Reflections on Map

“...when I was developing my map I said basically when I had developed it like I **developed it to show** that like what I'd come across with the current issues of video games like how they affect children and basically **when I am looking at this important issue that I saw was how adolescents are positively and negatively affected by playing video games** ... and the next part from there my early mapping basically when I first started out with this section the only thing I really had was just like the thesis or basically it was like the I believe / because ... and some of the current stuff now I saw and some of the current issues in this right section on my **map I was able to see that there that I was able to see** the people had had **different views** on video games ...

...then another source that I **used to connect** that still agreed ... so that's basically **what led me to see** that there is like **more than just one area of like different aspects** of ...

... for the last section I did have some change maybe not too much ... I still think some of the change came when I did like the next sessions which **when I connected them they were able to show me** like how people viewed the how this issue is a problem in different ways and I agree with them because I was able to **give me like a New Perspective** to how to view this issue ... so those were some of the things what I saw some changes there and **that gave me insight** to that and while the other that **there was a real game-changer for me**

Student #3 NP3 Map referenced in Narration Recorded

Figure 33a: NP3 Excerpts from Student #3 Map and Narration

it. I was also able to have my sources all together and ready to move over to my paper. Mindomo map also came in handy with the part where I had connected my thoughts to each of the sources. This gave me an idea of what I wanted to talk about and argue for each source. While writing my outline of Stage 3, I found that once I covered everything that I had on my Mindomo map, I was then at a loss of where to go from there. When that happened, I came to the conclusion that using the Mindomo map was actually convenient and more helpful. I did not have much to pull into my paper from my fifth through tenth sources and that is when I found complications on writing my paper. As much as I hated using Mindomo map and trying to force all of my thoughts out and organized, I believe I might end up using Mindomo map in the future.

- xfering from map → text (outline, structure, content)
- Map 1st, write 2nd

Comment [1]: I appreciate your honesty. As a tool for

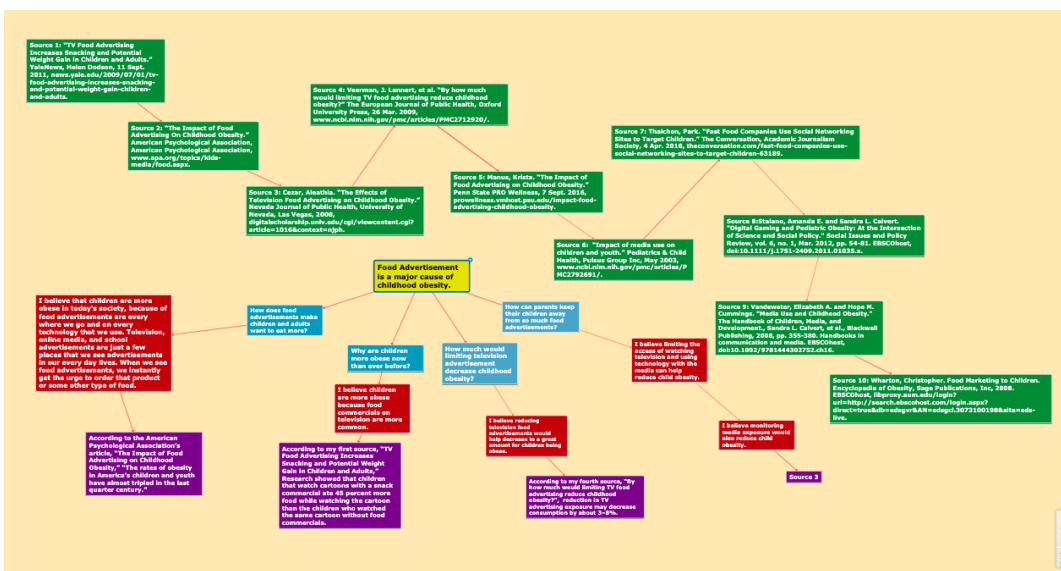


Figure 33b: NP3 Excerpts from Student #8 (Only Text Submitted, No Video Narration; Final Map Shown for Comparison Only)

Of course, it is important to stipulate the possibility that students bring with them a “way of thinking” that makes their map work seem more natural to their learning and meaning-making

practices, rather than a byproduct of the mapping exercise. For example, a number of student journals expressed a degree of prior experience with concept maps (or the cognitive patterns facilitated by mapping) as well as synthesis practices, suggesting a more significant role was played by prior knowledge in structural as well as conceptual connecting and construction behaviors, as opposed to being an outworking of mapping. This corresponds to Villalon and Calvo's research into meaningful learning, which describes learning as change, "a consequence of the integration of new material and the prior-knowledge structure" (300). While not every students' prior knowledge of mapping corresponds directly to concept mapping, students who expressed a lack of or negative previous experience with mapping seemed less confident or even resistant (Student #15, discussed previously, is one such example). However, those students like #8⁵⁶ and #10 (as well as #1 and #7) who persisted in applying mapping to their discovery and construction of new knowledge often made comments deeper into the semester that suggest they plan to continue using concept maps as part of their writing processes. Student #11's early and later thoughts on concept mapping use as shown below in Table 22 provides a representative of this trend.

⁵⁶ I believe it is useful to note that Student #8, in her final narrated journal submitted as text only and without any visual narration, commented that even though she indicated she had prior experience with concept mapping from high school, she "did not like it" because she "never really knew where to start." She remarks that this aversion continued into the start of this study, but through the extended process and directed scaffolding, experienced a change of attitude: "when we first start using the Mindomo map I hated it. [But] this last paper (stage 3) I realized that it was actually very organized to the point where I could basically just pull the information from my Mindomo map to my paper."

| Early Journal, Pre-Concept Map (Week 2) | Late Journal, Post-Concept Map (Week 14) |
|--|--|
| <p>“I have never used concept maps before however, the thought of using one is a bit overwhelming. I understand that it is great for brainstorming and organizing ideas into cute little bubbles and boxes but how? It seems complicated to link lines to specific boxes and make connections between . . . the two. Nevertheless, using a concept map, I feel will benefit me greatly regarding my thought process, my organization process, I’ve noticed that using a concept map develops my thoughts better and gets me into deeper thinking about my topic of discussion [this language is drawn from introductory material provided to students that describes the reason for using concept maps] . . . I have never used a concept map before, but I am very interested in trying it out for my assignments.”</p> | <p>“This part of my map I feel really develops my essay because it speaks on one of my main topics...”</p> <p>“The act of mapping this part of the map shows . . . the way digital media can seem like a ‘gateway’ to the knowledge of fitting in.”</p> <p>“My thinking has changed tremendously from my early map into my current map because I have done research on more of the psychological aspects of my argument... I feel that the changes to my thinking has been made because recently before I was not looking further into reasoning of why it seems that youth tend to do this. I didn’t feel I was expanding my thinking. Yet now, I feel that I can go even further into why and find valid explanations as well as back it up with source material...”</p> |

Table 24: Contrasting View of Concept Map Use from Early to Late Semester, Student #11

Our pedagogical approaches to teaching synthesis may be more productively deepened when we consider the neuroeducational factors involved by teaching this process of *making* by drawing upon cognitive benefits of graphically visualizing the enactment of that thought process. For example, when students are self-determining the design of their maps to represent conceptualized relationships between their research raw materials, data such as journal reflection language and coded behavior of designing (see Figure 12) suggest these maps represent embodied acts of knowledge representation and knowledge design. Instructional design based on examining sample texts, like essay passages assigned for reading and analysis, to teach synthesis may demonstrate to students what “looks” acceptable (synthesis’ rhetorical structure), but it may not show them “how to think through” the process to get there (synthesis’ conceptual structure). As Sousa points out, neuroscience research has demonstrated that even though our brains “store [new learning] by similarity . . . we retrieve by difference” (*How the Brain* 151). Thus, when journal prompts assigned to students asked them to consider how their mapped sources might be

integrated into a “conversation” related to their argument’s main points, student comments often referred to differences that become more visible due to their construction choices (position, labels, color, connector lines). For example, when students discussed their reasoning for their intentional color representation as they designed their map nodes, early results included language of “seeing” in terms of simple Listing patterns coded as KC rather than meaning-making (pattern building being one of the cognitive stages of synthesis). As the semester’s use of concept mapping progressed into essay writing, after week 9, translation opportunities from map to writing reveal movement from knowledge telling to knowledge transforming (more complex structures and meaning making in both maps and writing). An example of this is found in Student #3’s color choice/use references: this student’s early map journal makes no reference to color use; however, by the middle of the semester, she remarks that she is intentionally applied color coding to nodes for both affective (“to show how I felt about them”) and rhetorical function (“I used orange to give contrast with the sources in this section”). As this shift parallels increased representation mapping followed by reflection on its cognitive meaning, there may be some reason to believe there is a correlation to be made.

The Question of Transformational Goals for Instruction

Scholars agree that *transformation* is an essential characteristic of synthesis, whether it is structural or conceptual. Either form requires highly complex moves of *inventional* conceptual restructuring, moves that most would agree characterize experienced writers as opposed to novice (Segev-Miller; Campbell et al.; Johnson-Eilola and Selber; Boscolo et al.; Hay et al.; Atwill and Lauer). I propose that transformation must come from a pedagogy that operates from cognitive-based concepts of restructuring. Jonassen et al. remark that “[t]he learner begins to *restructure* his or her knowledge by adding *schemas* or developing new conceptualizations for

existing ones" (7; emphasis added). MBE scholars like Tokuhama-Espinosa, Willis, Sousa, Battro, and Hardiman provide the pedagogical connection to this cognitive-procedural feature of the CMAP intervention, explaining that MBE's classroom-focused theories can help teachers understand the cognitive *why* for making changes to pedagogy. For example, the conceptualization process that appears in both the maps and writing of Intervention students suggests that by overtly constructing CMAPS, students are performatively visualizing this process of schema building in a digital CMAP structure as agents of meaning making. Student journals contain reflection on this process that suggests that the combination of (1) designing a constantly evolving image of their active processing of incorporating new knowledge with (2) ongoing, recursive reflections on what these choices *mean* to their process of generating new knowledge *structures* creates deeper relational, associational, as well as conceptual understanding—precursors to the type of complex conceptual transformation required in synthesis.

The importance of visual heuristics (like mapping) to learning is not new to our pedagogy. However, if as instructors, we understand the *why it works* from the neuroeducational perspective, our interventional choices may be more precisely calibrated to employ them—as well as to help students understand and employ them in their own learning processes. Sousa summarizes that the “process, called imagery, is the mental visualization of objects, events, and arrays related to the new learning and represents a major way of storing information in the brain” (*How the Brain* 235). Such imaging is experience-based learning. Accordingly, imagery and image construction can be as powerful as “actually performing” what the mental image is representing (Sousa *How the Brain* 235). Bruillard and Baron discuss concept maps as a powerful “cognitive tool” (331) that situates students as designers, actively “constructing

meaning” visually: “learners as designers” (335). This concept of design is important to this study and appears to play out in my analysis of the data. While Bruillard and Baron’s work does not focus on writing pedagogy, their argument for the use of concept maps illustrates how a connection between MBE theories of knowledge and writing pedagogy can shape assignment design, such as the type of active learning occurring through these Intervention students’ construction and organization of the knowledge gathered during their research. This illustrates the concept of “participatory design,” as defined by Melanie Yergeau in *Keywords in Writing Studies*, which “foregrounds users as co-producers or co-designers” (53). Yergeau, in fact, makes reference to design’s central role in discussions of literacies, specifically the New London Group’s use of the terms as part of a ““meta-language”” (84). The New London Group points to the need to more carefully consider meaning-making as a multi-sensory activity, as this study attempts to do. The concept mapping activity integrates design as both a cognitive and action phase of research and synthesis writing, building on the NLG argument that “designing transforms knowledge by producing new constructions and representations of reality” (22). The contributions of a neuroscience lens here makes this claim quite literally, as the premise of this study has been to draw upon discursive knowledge from the neuro- and cognitive sciences, as captured within MBE scholarship, to look for manifestations of the brain’s neuro- and biochemical meaning-making processes in the act of *constructing* meaning.

Psychologist Lev Vygotsky’s work has greatly influenced our field’s understanding of scaffolding instruction, a cognitively-informed pedagogical approach to teaching the writing process. As synthesis is explored here as a cognitive-invention process, Vygotsky’s ideas on the scaffolded nature of learning *how to* conceptualize point to the importance of *teaching* synthesis as such a process (Lunsford 38-39). Prior recommends we consider the assignment as “the

initiating text” as it is the first step of conceptualizing, shaping as it does both the student’s path forward and the response (173). The results of this study—and research by other scholars (e.g., Eppler; Battaglia; Bruillard and Baron; Boscolo et al.; Colliott and Jamet)—suggest that MBE-informed pedagogy may provide writing instructors with models of assignment design and scaffolding that tackles the cognitive pre-staging of synthesis writing as a locus of explicit instruction. Johnson-Eilola and Selber argue that “as a field, we tend to remain fundamentally committed to that final artifact: the text that students produce The ghost of the authorial, creative genius remains standing between the lines, propping up what is an increasingly unrealistic artifact in our postmodern age” (378-379). While the process movement might offer a counterpoint to their conclusion, the importance of incorporating students as co-creative agents of learning into our pedagogy and assignment designs is a point well taken.

CHAPTER VI

CONCLUSION

This research project emerged from my interests in both pedagogy and cognitive science. That intersection provided immensely fruitful scholarly discussions of ways we teach and ways our students learn. The importance of metacognition to learning *and teaching* is indisputable, as seen in our field's work in teaching for transfer. As recently as 2016, however, writing studies scholars like Gorzelsky et al. observed that our disciplinary scholarship does not yet offer a “model” of instruction that deals with the specifics of teaching metacognitive strategies (215). While I believe this has changed somewhat given more recent scholarly work in teaching for transfer (Yancey et al., for example), there is room for more *applied* research—beyond the theoretical and into classroom-based research. As pointed out by those design-based research scholars who influenced my study's design choices, it is in the real-world classroom, with all its messiness, that I found the most productive space to study, understand, and ultimately teach the relationship between learning and cognition. Here at the end of my intervention's third iteration, there are a number of note-worthy “lessons learned” about ways concept mapping serves to highlight and illuminate what takes place in learning to synthesize as a cognitive invention process.

Lessons Learned

On Concept Mapping & Design Theory: Bridging Gaps in Pedagogy

I believe the results of my research reveal a great deal about significant gaps in our synthesis process pedagogy; one of these is explicitly teaching conceptualizing as an act of invention, a view that should inform the way we teach and learn metacognitively-robust approaches to synthesis. By framing my study's design with a focus on learning to synthesize

knowledge as a generative process, I examined concept mapping as a representation of students' performative meaning making as they relate new information to prior knowledge in the process of *constructing* connections. By deploying concept maps to help students make their own learning processes visible, I believe the instructional strategies described in previous chapters promote a different experience of synthesis as an inventional cognitive *process*, one that provides students with a personalizable, visual-based constructivist tool with which to enact their own agency in ways that reading-to-write teaching strategies may not do as explicitly. To that point, I believe my research results suggest that taking an approach to synthesis instruction that is supported by ongoing and reflective concept mapping work provides an important alternative to instructional approaches that rely more on a linear-based choosing/combining textual production. (While the Control Group was intended to provide a comparative example of this approach, the limitations previously discussed in the Results and Analysis chapters prevent a more conclusive comparison.) For now, I can only state what writing classroom instructors and composition theorists know: a linear approach to invention is not how learning to write actually works. Despite this, I discovered too often that instructional materials like textbooks and heuristics (especially those targeting instructors who may not be deeply immersed in rhetorical and writing theory⁵⁷) regularly seem to promote such a linear pedagogy.

Further, the results of this study seem to suggest that our synthesis pedagogy is enhanced when we make space for teaching and learning how to *conceptualize* (i.e., build new concepts), in particular by explicitly teaching conceptualizing as a cognitive-invention process based on

⁵⁷ Josh Sunderbruch's research summarizes this concisely: "The great majority of composition instructors are not composition specialists, however; they are experts in literature or creative writing—or graduate assistants—whose primary contact with composition theory and composition models is through their textbooks. The textbooks (often written by actual composition scholars) are where theory and context meet; they are the texts which most often guide praxis and pedagogy" (3).

students' agency as knowledge *designers*. Even with the study's limitations, I believe the results strongly suggest that this DCMAP intervention serves this purpose. Specifically, I believe these results illustrate that when instructional language used to frame synthesis activities in the classroom incorporates the language and concepts of *designing* as a metacognitive constructive process, it has the potential to help students comprehend their cognitive processes in terms of their roles as active and intentional designers of knowledge. For example, the mapping-as-cognitive-representation language I employed provided my students a productive, cognitively embodied way to enact these concepts visually within the design framework of their map construction. Specifically, I found that asking students to "engage" with sources when "joining a conversation" (two particularly abstract teaching phrases) is less difficult for students to understand when the design of the instructional intervention guided them through *doing* "engagement" and "joining" *as a form of* cognitive conceptualization and meaning making.

The concept mapping intervention allowed me to present conceptualization to students as a process step of learning to synthesize (as both a metacognitive as well as a performative practice). This is a stage of the synthesis learning process I found lacking in most teaching materials, especially on an explicit-instructional level. As was the case in my Control Group's results, which used only a reading-to-write teaching strategy for synthesis instruction, students' *conceptualizing* process efforts remained relatively non-explicit, perhaps suggesting that students' understanding of how to practice synthesis was limited to simply choosing and adding as their goal in terms of the cognitive and structural transformation of ideas. As my study unfolded, I began to believe that the missing piece of student synthesis learning is the overt enactment of conceptualizing as a cognitive invention practice. Through the process of representing and constructing connections in their reflective concept mapping, students' mapping

provided them with a platform for visualizing engagement and joining at a cognitive level. As a result of combining this with continuous, simultaneous reflection on their designing process to make meaning, the results suggest this focus demonstrates the benefits of integrating a cognitive-visual approach to synthesis instruction.

On Heuristics for Teaching the Cognitive Process

While our field's pedagogy asserts that *how* we teach writing is significant, I would argue that how we design interventions to teach *the cognitive process* is more so. My study asks how best to create more effective hermeneutical heuristics and assignments for synthesis learning. What I discovered through this research process is that novice writers seem to benefit from a cognitive approach to synthesis process instruction. However, this approach comes with risks, such as cognitive overload. Cognitive overload is a constant struggle for novice writers, and the addition of yet another layer of process, using an unfamiliar technology at that, may have produced unintentional overload. Still, I found that by providing my intervention students with a means of offloading some of their process connections through mapping as a collaborative, paced, long-term exercise (a learning behavior with which many of them had some familiarity according to their journals and questionnaire responses), it produced enhanced opportunities for dual coding as they learned to *visually* integrate pre-existing knowledge with learning objectives (i.e., synthesis writing) in both the designing of their concept map spaces as well as their writing texts.

Another risk I encountered is the degree to which students are unable to recognize or navigate the abstract nature of cognitive processing. As this abstraction is a key operating premise of my instructional materials, the potential for overload and confusion was a constant concern. Our novice-level college writing students are not only struggling with abstractions and

conceptualization, they are also too often unaware of their own *processes* involved in these two essential critical thinking practices. Thus, I set out to explore what might change if my synthesis instructional intervention was designed to help my students *see* (as both an act of recognition and visualization) the cognitive processes at work in synthesis conceptualization and writing. This is where I found that the ongoing and scaffolded workshops of the DCMAP rather effectively provided a medium and space for representing and facilitating an invention process pedagogy to give students the scaffolding (physical and cognitive) needed to move from one level of thinking in concepts to the next (a key element of successful synthesis). Still, some additional slow-down time needs to be built into future applications.

Finally, as I demonstrated in my Literature Review, interventional heuristics often fail to account for what Petrie and Oshlag call the “epistemological chasm” (583), especially in terms of enacting student agency and cognitive processing scaffolding. As my review of the scholarship reveals, instructor-designed heuristics that rely too heavily on a fill-in-the-blank or sentence-level structural modeling approach to teaching synthesis tend to skip over teaching students the process involved in conceptualizing, and therefore do little to foster the benefits of the learner-as-designer model used here. There were times when scaffolding worksheets felt like this. In future applications, however, increasing balanced recursive-reflective activities may help mitigate this concern. The type of meaningful learning processes illustrated in my data are made possible because the recursive combination of reflection, designing, and construction provides explicit opportunity for invention in an ongoing, connective building between, as Ifenthaler et al. observe, what is known (pre-existing knowledge) and visualized and what is yet to be understood as acts of transformational invention.

On Agency

This study provides another answer to “why concept maps” in the form of rhetorical agency afforded and facilitated by the intervention. Here, I agree with Marilyn Cooper’s observation that our students often lack the type of self-awareness that allows them to consciously and closely monitor their motives for making their writing choices. For this very reason, and because studies on embodied cognition clearly point out that our bodies and actions are integral to our thinking processes, the reflection opportunities of my study proved essential to creating for students a visible and actionable process that moved them toward recognizing their agency as rhetorical knowledge builders. I believe my study’s findings are significant in that they suggest cognition, like writing and invention, is never limited to the solitary location of thought, and must therefore be given a more explicit role in the writing process—both instructional and practiced.

On Knowledge: Through the Looking Glass of Design & Cognitive Theories

Our mission as writing instructors is to help our students become reflectively aware of not only the Academy’s models of knowledge making, but also their own meaning-making agency in the processes that contribute to addressing those (and other) models of communication and research. In research writing, students often exert their agency in their use of digital affordances to guide their meaning making (lateral reading via hypertext links, use of graphical interfaces like emojis and gifs, YouTube and Wikipedia, etc.), yet it is often unconscious and unreflective behavior. This carries implications for students’ epistemological and inventional behaviors. Therefore, it seems logical to pursue the type of instructional intervention, framed and infused by cognitive research, demonstrated by this study, an approach which asks students to not only create visible traces of their acts of construction in a map, but to continuously examine

why. As our field's approach to multimodal writing suggests, I believe we owe our students a deeper examination of the cognitive practices involved in "how to do" conceptualizing by following (i.e., mapping) their generative processes of active learning in this way. To achieve this, I relied on Jonassen and Reeves' observation that framing our students' understanding of knowledge in terms of design can help us move students away from perceiving and engaging with knowledge as mere packets of information, and make the shift toward a collaborative relationship with "the knowledge construction process" (704). By doing so throughout this study, I did not simply foreground the agency of students in practices of invention (synthesis). I also necessarily reframed my instructional approach and materials to overtly focus on the *mediating* cognitive phases of epistemological and rhetorical invention involved in the creative practice of knowledge integration and transformation. I discovered that the affordances of multimodal design pedagogy I employed to design this study of DCMAPs productively served as a mediating scaffold-construction medium for students to enact and explore their own cognitive processes in a way that created explicit traces for their own inquiry and reflective invention (i.e., meaning making).

These generative and active learning theories provided my work with numerous productive resources to counter the limitations of current approaches to synthesis instruction. For example, I believe there is a significant but often unresolved tension in the humanities that directly impacts the way we approach synthesis in terms of both pedagogy and cognitive invention: the influence of print-oriented traditions (like literature and composition) upon 21st century pedagogies when it comes to guiding learners to navigate the spaces and practices of invention and conceptualizing. While I take issue with those who might assert that text and print are in the decline (like Hayles), there is no doubt that the current generation of students we teach

in first-year writing is steeped in processing digital spaces, and therefore practice (perhaps unaware) a cognitive process influenced by their affordances, both embodied and networked. This became clear in my study, when students often remarked that their prior experience with mapping was one which made limited use of the network of affordances of *concept* mapping; yet their reflections and concept map constructions suggest that drawing upon familiar visual practices (such as color-related meaning making) provided an accessible way to “see” their progress and perform new constructions and relationships. Based on this observation, I believe our theories and pedagogies of synthesis stand to benefit from integrating such prior knowledge of design into our instructional choices, as the concept mapping of this study has attempted to do.

In sum, as a result of this exploratory research, I find that concept mapping as an ongoing process-based invention space offers a soundly theorized approach to guiding students toward more deeply and reflectively examining their knowledge structures and conceptual transformation. As my preceding chapters have established, the benefits of concept mapping have already been applied across disciplinary fields to help students map out summaries of pre-existing knowledge. However, as the results of this study demonstrate, using mapping as a *scaffolded mediation* of the embodied nature of conceptualizing also offers promise. I believe my study’s results illustrate what design and concept mapping scholars like Nesbit and Adesope have long observed about the benefits to learning: students who employ concept mapping to identify and represent “the internal connections among concepts presented in text” are performing an “act of translating” as they move from text (reading) to visualization (the maps’ nodes, connector lines, and spatial design affordances) (419). Such *practice* in translating is a conceptualization step that is sorely needed, and one that students in this study seemed to embrace. As evidenced throughout their reflection journals, such dual coding processing asks

more of students' cognitive efforts, scaffolding "up" their meaning making practices. Even though the intervention students' attempts to make the translation back into text are not always fully realized in their final essays' synthesis passages, students' reflections on their invention and planning processes, both within their maps and when translating from maps to their writing, offer a clear view of students' practicing as knowledge *designers*. This is not as visible in the text-only writing practices of the Control group work, suggesting a mapping mediation provides a valuable process piece of the cognitive puzzle of synthesis thinking and writing.

On "Making" New Knowledge: Understanding the Space & Structure

When instructors design interventions that incorporate concept mapping as an active learning process mediation, it is vital to not simply "tack it on" as one might a prewriting, pre-structured graphic organizer (Morton). Indeed, as I learned from designing this study, the use of pre-structured maps, mapping software that dictates (i.e., preformatted) a limited hierarchical ordering of ideas and sub-ideas, or teacher-dictated construction beyond initial orientation defeats the epistemological purpose of positioning students as knowledge *designers*. The concept map is not, by itself, a rote learning solution. When students are asked to create their own concept map, as they did in my study, their roles as learners necessarily shift from simply knowledge acquisition toward agents of knowledge design. The flexibility of the concept map intervention studied here, where rhetorical invention as a cognitive process is facilitated by overtly situating students as agents and co-designers, depends on *prior knowledge*. Like Yancey, in my study I frame prior knowledge as more than simply student content knowledge; it also includes writing processes, sites of writing, and affective influences (Yancey "Mapping" 314). However, as a teacher, I cannot assume this prior knowledge adjusts for the impacts of technologies (from paper to digital platforms) on students' composing processes. Choosing the

concept mapping platform, and modifying its use from iterations 1 to 2, and from 2 to 3, I found myself drawing upon Jody Shipka's charge to consider how my technology choices would provide a way to identify all the ways that using the mapping as part of students' composing processes might be connected (36). As I discovered through this series of iterations and decisions, the mapping software (medium) provides the type of additional *where* of writing Shipka refers to, a space that needs to be assessed in terms of the cognitive moves it allows, from thinking about writing to the actual designing of knowledge construction (176). In short, we (both instructor and students) benefitted from paying closer attention to how the mapping space and affordances both reveal and facilitate the cognitive processes (both the how and the where) that occur as the cognitive precursor to synthesis writing.

In short, I believe my study has reaffirmed why using CMAPs to examine the structural practices of student writers may be so important, an observation shared by many scholars studying reading-to-writing (e.g., McGinley, Segev-Miller, and Spivey). However, invention and synthesis instructional strategies often favor a linear pattern that privileges the act of reasoning as a trace associated with reading and writing. My study explores an alternative to this, where the incorporation of visualization was added to capture more of the complexity of the exploratory cognitive process and processing that takes place interstitially (i.e., between reading and writing). These results demonstrate that in CMAPs, structure matters, and not just as a surface-level trace of connecting nodes as bits and pieces of information. The *process* of *actively* and *reflectively* building that structure matters. In designing this intervention, as well as analyzing the results, I leaned on Jonassen et al.'s observation that paying closer attention to such structural knowledge leads us to better understand the *why* (an act of conceptualization), a feature of critical thinking which instructors try to elicit with reflective writing. As a *synthesis* component, this marks an

essential precursor to *transforming others' knowledge*. When it is used as a heuristic thusly framed, as a type of knowledge representation, it is necessarily and simultaneously playing a hermeneutic role in terms of *constructing* knowledge. Concept maps' networked appearance serves as a visual reminder of this. I presented DCMAPs to students as a metaphor of mapping their knowledge both structurally as well as metacognitively; in doing so, this essentially created a mediational space for cognitive action. Mapping then implements students' pre-existing knowledge (what does a map look/do; how is source knowledge represented) to help them form a conceptual framework for their map use in terms of constructing knowledge that relies on relational *plus* associational cognitive processes.

It is beneficial to consider the concept and operation of metaphor to ask: how does it work, cognitively and epistemically? In answering, I find Petrie and Oshlag's work on learning helps me explore this question in relation to the goals of my research question on employing CMAPs in both heuristic and hermeneutic capacities. I believe the metaphors that are most helpful to learning are those that are interactive⁵⁸, especially when learning is defined as change. Students in this study expressed that they often discovered that their mapping led them to create new knowledge by graphically altering the way they chose to connect, associate, and represent both others' knowledge as well as their own (i.e., representations of their cognitive invention). Metaphor, as I have argued elsewhere, gives these students what Petrie and Oshlag describe as "a rational bridge from the known to the radically unknown" (584), and goes beyond assessment value (the teacher's learning goals applied, the traditional role of an heuristic). Such an

⁵⁸ Petrie and Oshlog define this interactive nature of metaphor as one that goes beyond "transfer[ing] meaning and understanding by comparison" to actively create (radically) new knowledge. In the case of the DCMAP functioning as an interactive metaphor (in the constructivist sense), the mapping "creates similarities" to "provide the bridge between a student's earlier conceptual and representational schemes and the later scheme of the totally unknown [i.e., synthesis as radically new knowledge] subject to be learned by the student" (Petrie and Oshlag 585).

interactive map metaphor then, when operationalized in a DCMAP-based intervention, appears to facilitate opportunities for students to more deeply explore the results of asking *how* and *why* in order to change their pre-existing habits of representing synthesis (e.g., listing and summarizing acts) by physically representing and graphically *engaging* in the construction of new relationships in ways that sentence-based knowledge building may not readily facilitate.

These modes and methods of representation also implicate our teaching materials: what they ask students to do, how they ask them, and what prior knowledge of processes and procedures students draw from (i.e., previous writing courses at, in this case, the secondary school level) to complete the required task. Specifically, as synthesis scholars like Mayhan and Segev-Miller note, student experiences with writing synthesis tasks as defined by prior instruction at the high school level necessarily informs how they represent the task in their college writing classrooms, what Yancey calls the “invisible school-based contributions of the prior to students’ composing practices” (314). As college-level instructors, I believe we need to do more to take this into account when designing our own instructions for synthesis tasks, especially knowing that students’ understanding of “how to” synthesize will necessarily reflect prior experiences, which by most reports rely on listing, simple combining, and summarizing. The decision to apply a DCMAP heuristic was an effort to bridge this gap, as a means of providing students with a familiar metaphor (mapping) to explicitly signify their cognitive moves when actively designing and representing their own pathways of knowledge building. I believe, in this respect, this intervention was successful.

Addressing Limitations: Future Iterations & Research

Still, there is work left to be done. As indicated in the Analysis Chapter, a number of limitations encountered during the study reveal areas for improvement.

Instructional Limitations

As I mentioned in the Analysis chapter, I believe future iterations need to incorporate several changes, including additional student interviews, both throughout the semester as well as at the end of the term, as well as modifications to some of the explicit instruction given to students as they mapped. Just as Pavio and Walsh observed, I found that when students combined image with verbal associations and representations, they seemed to employ what dual coding theory describes as the interconnected nature of cognitive processing. For my study, one of the more significant findings as related to student learning is the flexibility inherent to image processing, which emerged as an important result from student journaling about their mapping as it appears to free students from the limitations of common linguistic-only structures (i.e., sentence and paragraph building or outlining and organization) as the lone synthesis strategies available. In order to better reinforce students' practice of creating and discovering as inventional knowledge design (i.e., synthesis as a cognitive invention process), I believe future iterations will need to add more guided reflective opportunities. As I suggested in the Analysis chapter, I believe these might be integrated as ongoing process journaling at strategic moments of students' progress.

One possible revision might be to schedule a *recorded* early conference, a mid-conference, and an end-of-term conference, and provide a guiding question to students prior to the meeting so they will have time to think through their reasoning. Another option would be to build in more "why did you make this round of changes" questions, with more explicit design-based questions, as an in-class journal writing task. When doing this in class, students are more apt to actually complete the writing (although no guarantee). It is possible that students had never before been asked to record their own thinking, and so defaulted to simply narrating "what's

there” as opposed to explaining “why it’s like this.” Therefore, in future iterations, I believe it will prove more helpful to change original, early journal prompt language from phrases such as “how does the map demonstrate ‘how you got there?’” to language that draws attention to “why” mapping choices (use of colors, shapes, and other design features) represented their thinking. This shift does occur in the final (Weeks 15 and 16) journal prompts, but by then the advantages of that shift appear too late in the process.

Another reflective opportunity I see worth adding in the future is to give the History feature of the Mindomo map a more prominent role in the reflective writing performed by students. In this current iteration, only one journal entry was assigned that asked students to review this function of their map creation; this was assigned as an optional entry at the very end, in one of the late additions to assigned journal writing. I believe this feature deserves a closer look, and it would be useful to create a teacher-student interview to discuss what the students “sees” in the unfolding history. This would allow me to ask questions like “Why this? What did you see ‘here’ that made you decide to ‘go there?’” Such questions, I believe, might allow students a more naturalistic setting (using a think aloud protocol) to explore their reasoning while visibly tracing their final maps *prior* to writing the final essay in weeks 12 and 13.

Related to this tracing opportunity, more intensive class time is needed to explicitly demonstrate the cognitive tracing students’ maps provide to them; handouts and verbal instruction, combined with in-class demonstrations, may be enhanced with more overt discussion of how metaphors like mapping function by helping us *transform* knowledge. As previously mentioned, studies suggest (not surprisingly) that our students interpret and practice synthesis writing tasks through the lens of our instructional materials and pedagogy. Studies that point to inconsistencies in how synthesis is defined may certainly suggest that if teachers are unsure or

simply assume students share their own internalized understanding of the term's meaning, any disconnects between student and teacher instructional material will impact instruction, both on implicit and explicit levels. Therefore, in the future, I believe it would be productive to spend more class time on combining explicit instruction and modeling on the process of *transforming* knowledge. This may be deepened not only by assigning additional reflective journaling, but by adding more time for in-class collaborative discussion of students' mapping construction choices. By adding metaphoric purpose-based language to guide informal, collaborative group discussion of their design choices as representations of new connections or intent, I believe students may feel more comfortable exploring ways their maps actually change the nature of the individual nodes of information by creating new links. This collaborative event would then be followed by immediate, in-class journaling to record their thinking, as well as the influence of what "others" see in their maps. As this study argues, "conceptual transforming" (Segev-Miller 24) is the key to successful synthesis, and future iterations would certainly benefit by incorporating additional, explicit instructional activities to enhance such student tracing behaviors.

Other Limitations

While the environmental limitations noted in the Analysis chapter could not be anticipated or corrected for in future iterations beyond what has already been discussed, other design-based limitations such as those of the Control groups' data can be addressed. The most important adjustment to any future research design would be to create a more correlative set of data (Interventional + Control) by addressing the variables discussed in the Analysis chapter. Several possible solutions have already been offered there, and so will not be repeated to any degree at this point. However, it is worth observing here that these complications are typical of

DBR methodologies; situated as researcher-as-teacher within the “messiness” of a classroom, my role as instructor/observer and researcher/designer was complex. However, as the focus of my study was on the *possibilities* afforded by the CMAP intervention, I believe any attempts to create an overly prescriptive and empirical study design may have complicated that focus. However, it would be more illuminating if Control data had been more uniform in content; therefore, the next iteration will likely include Control group instructors as part of the research team.

It is important to note that my study—and its associated scholarly support—suggests that pedagogy that uses only a reading-to-write method to transform knowledge on a textual level cannot be sufficient as a stand-alone pedagogy. The way in which we teach synthesis directly frames our students’ own representation of the tasks and processes invoked in practicing synthesis, and this may best be achieved with a more pronounced cognitive focus as part of our process teaching. Therefore, if *conceptual transforming* is the goal of our synthesis pedagogy and instructional design efforts, we must ask ourselves, as I attempt to do in this study: what are we really assessing when we assign a synthesis task in first year writing (or indeed, for any writing assignment, including graduate-level instruction)? What is synthesis a marker *for*, and how do our instructional interventions better help students engage with the cognitively generative processes of *inventional* synthesis as an essential part of their learning pathways? For this reason, insofar as future iterations of this intervention are concerned, I believe increasing the number and types of reflective sites associated with the cognitive process of mapping (e.g., additional journaling and interviews) throughout the semester’s process may enhance students’ writing process learning by adding the “process of knowing” as a learning objective (*How People Learn* 10).

In addition, because reading instruction and reading comprehension certainly play a role in the synthesis dilemma, an additional modification to future iterations will be to add selective reading-map activities early in the term to create yet another modeling bridge for students. I envision these as a series of brief, in-class guided collaborative activities during which small groups of students work together in a DCMAP space to create a cognitive map of synthesis passages found in assigned reading selections. These cognitive maps would be based on a series of “why” and “how” based exploratory design questions to illustrate the type of questioning students will be asked to do in their own mapping. An example of such a question might be: “How would you create this paragraph’s connections between source ideas using the map affordances of nodes, lines, and even other design features like color to show importance or priority?” Thus, this addition could serve as another modeling/scaffolding stage to allow students to engage with the affordances of the concept mapping software as tools for representing their thinking and decision-making processes when creating their own maps.

Implications for Our Field

By applying an interdisciplinary approach grounded in rhetorical invention, I believe this study illustrates one possible way forward to respond to the call by many writing scholars to look more deeply into synthesis practices of our first-year student writers. By all accounts, synthesis is hard to *do* and to *teach*; therefore, this study intentionally integrates CMAPs as both a learning *and* an instructional technology to draw additional focus toward design strategies invoked in knowledge building processes. As my results demonstrate, DCMAPs become a contextualized site for students’ visual representation of their *acts* of knowledge building. As previously discussed, my study’s framework and subsequent analysis of results draw from theories of invention, and in particular from the work of Janice Lauer, to focus more intently on synthesis as

it can be taught as an act of intentional knowledge construction (a creation/invention process). Results of my study demonstrate the observable benefits of teaching students to consider such knowledge construction as first a cognitive process, strongly suggesting that instructional materials can be enhanced by employing designs that draw from dual coding theory, concept mapping research, and MBE scholarship. Here again, I find Lauer's work on rhetorical invention prescient, as her theories on the importance of visualization to meaning making guided my decisions to combine visual with verbal invention practices as a way to enhance students' abilities to construct new knowledge pathways.

I firmly believe that the DCMAP as deployed in this study is a way to make such pathway building explicit, thus facilitating Prior's recommendation to writing instructors to trace the writing process to tell if synthesis is happening not only by observing students' creation of visible map as well as written markers of knowledge, but also by exploring student reflections on the construction *process* as vital stages of their developing structural knowledge strategies. The maps these students constructed as the result of these interventions can thus be interpreted as representations of the types of complex structures made visible and possible due to their developing understanding of their own agency as meaning makers, and their awareness of their own creative agency in the act of synthesis-as-invention.

Future Impacts: Relevance to Writing Instruction

As synthesis is a writing and thinking ability that is assessed across all disciplines and stages in college writing (and certainly beyond), I believe the focus of this study carries relevance far beyond the composition course and the research essay. For our field especially, I believe this study draws needed attention to our disciplinary approach to the *concept* of synthesis as both practice and artifact, a question of not just transfer but *learning*. Throughout this study's

evolution, I argue that *synthesis*, when framed as invention and taught as a cognitive process, merits treatment as a threshold concept (as defined by Adler-Kassner and Wardle). After all, as Flower notes in “Negotiating Academic Discourse,” the type of cognitive processing students employ when weaving together personal knowledge with discovered information is a practice that defines much of academic writing. It is also one that too often serves as a boundary and barrier to successful entrance into the academy’s discourse community. Therefore, an instructional design or heuristic that facilitates border crossing at the level of conceptualization is surely one that promotes the definitional purpose of synthesis as a threshold concept.

I believe such a shift in view impacts not just the first-year writing classroom; it also carries ramifications for addressing the writing knowledge/practice gap that exists between the move from high school to college, especially when exploring ways to improve our repertoire of instructional approaches to such a critically important—and critically difficult—cognitive practice as synthesis. As this study illustrates, for novice/novitiates to academic discourse practices (both writing and cognitive processing), the constructive process of synthesis is a tall request. The concept mapping intervention and instructional design explored in my study appears to offer promising transitional scaffolding tools and opportunities—practices that foster not only reflection but intentional cognitive *awareness*. Based on my observations of students’ processes and artifacts, the CMAP certainly appears to serve this purpose in a number of ways, at a number of cognitive levels. This intervention asked students to *transform* their prior knowledge into a visualized network of representations, patterns, and discovery, and in doing so I believe the results demonstrate that affordances of the map itself embody and encourage the types of construction strategies that appear to facilitate for students an enhanced awareness of their rhetorical, structural, and conceptual invention processes.

The importance of *teaching* “knowledge transformation” is part of this equation, and these results seem to confirm that a visual approach such as CMAPs provide may make this conceptual task more overt and therefore more accessible for inquiry and enactment. I believe situating students as knowledge designers as this study did also helps them make the transition from performing as knowledge tellers or reporters into seeing themselves as agents of knowledge creation by breaking down a complex cognitive process into a visible process of construction choices. As I have demonstrated in this project, learning to develop a mental schema-building strategy is complicated; I believe the results of this study suggest that adding more in-depth conceptualization scaffolding through intentional and reflective visualization adds a necessary process activity to our pedagogy and classroom praxis.

In answering my research questions, I found a shared emphasis among many of the early cognitive and invention scholars described in my Literature Review: that is the importance of students’ awareness of their own thinking and writing processes. These “invisible” traces of students efforts to represent their knowledge- and meaning-making have been addressed to some degree by the Process movement, but not entirely successfully (or without critique). This study attempts to address this “unseen process” gap of our traditional (i.e., reading-to-write) approaches to synthesis pedagogy as the domain of cognitive work. If we accept my premise that synthesis is, by its very rhetorical and cognitive nature, invention (creating new knowledge), how might we—as classroom instructors and as a field—adapt our instructional design to support this? I believe this study demonstrates one way to create such a context of learning and practice.

Final Thoughts

I believe my study demonstrates the value of making the work of cognitive invention visible. Comments made by students in their reflective work repeatedly mention the value of

concept mapping to their thinking and “seeing” in the process of discovering and writing new ideas and connections. Their comments frequently allude to the metaphoric function of a map, as a guide to emerging pathways as well as a structural schema building scaffold. However, such observations suggest students benefit from the maps as more than a building scaffold; their cognitive awareness increases and, in the process, contributes more overtly to their construction choices. While it is an older publication, the work by Schumacher and Nash offer an appropriate view of metaphors as having both cognitive as well as semantic functionality, a fruitful means of moving from the known to “radical” or “new” (a la Bloom’s Taxonomy) knowledge and concepts.

Like Eppler, I advocate for integrating concept mapping as a visualization heuristic alongside the more familiar read-to-write heuristic approach to teaching synthesis. As I believe my research has demonstrated, the very complexity of synthesis (as both a cognitive and a writing process) demands a more forward thinking approach to the types of structural knowledge, one that employs the processes of dual coding to construct and connect concepts (Morton; Pavio; Nesbit and Adesope). Segev-Miller’s work is one of the few available on synthesis practices (of both writing and teaching) as an object of study. Like her, I think student success in synthesis is too often measured by the synthesis end game—the written essay—and so goes the pedagogy. However, I also agree with Segev-Miller’s observation that shifting our pedagogical efforts toward developing students’ cognitive processes, and how those processes lead them to create both mental and written schema, offers a way to guide students to more successful and agent-based synthesis efforts.

I stand with several of the contributors to Adler-Kassner and Wardle’s *Naming What We Know* in believing that when we approach synthesis and synthesis writing only in terms of

producing a textual product, we risk affording less instructional emphasis and spaces for that which takes place on a non-visible (i.e., the cognitive) plane. Such focus on the text may also diminish the potentiality of the generative process involved in terms of creating new pathways for thought—an act of invention. If we accept the premise advanced by Process Theory (as well as current Transfer Theory) that writing leads to new understanding, it behooves us as pedagogues and researchers alike to advance synthesis instructional practices that promote such a *generative* approach to creating, not simply locating, knowledge as an ongoing act of constructing mental schema (a conceptualization process that is key to learning). As Louise Wetherbee Phelps once observed, the relationship between theory and practice is one fraught with tension in our field . . . indeed, perhaps in any humanities field for which the object of study is the messiness of classroom learning and teaching (“Practical Wisdom” 864). At the risk of pushing this idea beyond its intended purpose, considering knowledge in physical, structural terms has significant value in terms of this project’s use of concept mapping as an epistemologically generative/inventive space and practice.

This study applies design-based research methodology to an interdisciplinary-theorized framework to explore what is often seen as the domain of rhetoric and composition studies: teaching synthesis writing. I believe this is a timely and productive approach because of our field’s current interests in transfer pedagogy. As highlighted by Yancey et al., transfer pedagogies often employ efforts that strive to help “students *think like* writers, in particular through the use of reflection” (4; emphasis added). To do this as I explore in this study, I believe we must also help our students learn the process and practices of conceptualizing. Reflection—a staple of transfer theory—does not happen intuitively, an observation shared by many cognitive and composition scholars. Indeed, this develops over time—nearly twenty years, according to

most neuro- and developmental scientists (Kellogg and Whiteford). Of course, this also requires that our pedagogy likewise provides students with the time and sites needed for scaffolded learning activities that facilitate, in explicit ways that invite students' co-creator status, complex cognitive processes of invention and construction that tap into more than just hierarchical structures of text building. To help our student writers succeed, integrating hermeneutic heuristics such as concept maps to develop student awareness of writing at both the rhetorical and the cognitive levels can provide more depth to our process instruction, the type of cognitive depth needed to help students understand (and then practice) what it really means and looks like to transform knowledge.

In closing, I want to return to an observation I made earlier in this study, when I pointed to the role of "lore" in classroom practice to set up the contrast to research- and theorized pedagogy. I wish to clarify that observation, in the fullness of context: all too often, "teaching lore" is devalued in conversations about pedagogical research. This is unfortunate, as classroom-based experience is an essential component of all our fields' work. Lore has a place in our classroom; part of composition's strength is its ongoing adaptability and the flexibility afforded by its interdisciplinarity. The precedent of classroom-based and instructor-generated lore teaches us a great deal about what works and what does not; what critics of lore may actually be searching for is a clearer, reproducible understanding of "why" it works. The abundance of scholarship emerging from MBE fields, along with continued studies within our own field into the cognitive elements of learning, provides me with a clear path toward addressing the *why* of synthesis pedagogy and learning in this small-scale study. Writing scholar Scott Wible, arguing for a design thinking approach to teach writing, puts a finer point to this goal, as he refers to the NCTE Framework's emphasis on creative thinking and how some writing scholars have

embraced this move. In particular, he cites Richard Miller and Ann Jurecic, who observe that “divergent, creative thinking can’t be taught by rote” (Miller and Jurecic 12) but needs “repeated practice in ‘paying attention’” (Wible 400). Too often, I argue, our pedagogy has relied on what may amount to such “rote” instruction in the sense of framing synthesis as a writing process skill, when in fact it is a generative, cognitive process that is highly complex and requires we *back up* in our instruction to help students learn more about *how they think*, to explore what is *behind* that process of constructing knowledge generatively. This process requires training and practice in conceptualizing structural/rhetorical knowledge. This project’s concept mapping-based intervention seems to be a promising method to address that need, worthy of additional research.

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APPENDIX A

TOOLS FOR CODING & MEASUREMENT

1. Visual Design Features of Map

Coding Tool 3: Visual Design Features of Map

NOTES: Design / Designing Features of Moves used to "detail and visualize relationships b/w ideas (Davies 2010)," as cited in Medvedeva & Recuber, 140

- column one = descriptive code list; use other columns for examples, what to look for
- Following Descriptive / Process coding method (Saldana)

| | | | | |
|---|---|---|--|--|
| Assembling / Constructing | Nodes: <ul style="list-style-type: none"> • Number • Shape • Position | Connector Lines <ul style="list-style-type: none"> • Used / Not Used • Design | Label Boxes <ul style="list-style-type: none"> • Used / Not Used • Alternate Placement | Content <ul style="list-style-type: none"> • Source Knowledge • Student Knowledge |
| Connecting / Linking Representation | Representation: <ul style="list-style-type: none"> • Labels • Lines • Arrows • Colors | Relation Building: <ul style="list-style-type: none"> • Vocabulary Terms • Color • Spatial • Arrows | Narration: what is happening here? <ul style="list-style-type: none"> • Here / Not Here | Narration: why this is happening here? <ul style="list-style-type: none"> • Here / Not Here |
| Generating [Process or Evolution] | Progressive Changes In: <ul style="list-style-type: none"> • Structure • Design choices • Content | Pattern Building: <ul style="list-style-type: none"> • Like / unlike • Pro / Con • Claim Types • I See | Themes: Big Picture <ul style="list-style-type: none"> • Course goals: Rhetorical • Student goals: Conceptual | Category Building – Organize <ul style="list-style-type: none"> • Rhetorical Product • Conceptual Product |
| Transforming / Conceptual Restructuring | Color <ul style="list-style-type: none"> • Symbolic ("this means") • Non-symbolic (category) • Other (I like) | Multimodal <ul style="list-style-type: none"> • Used • Not Used | New Directions (Category Building) | Text (E of SIEL) (non-source language) |
| <ul style="list-style-type: none"> • Assembly / Construction [Tools Used For Building]: nodes, connectors, content, labels • Connection / Linking [Representation]: labels, lines/arrows, category building (colors / space) • Segev-Miller's Conceptual Restructuring = Transformation [Rhetorical & Conceptual]: space, colors, multimodal, connections, non-source ideas emerging via explanation, elaboration [E of SIEL] ... "this means" or "I see" • Generation (identifying patterns, themes): progressive changes in map structure signaling Invention Process (p re-synthesis markers) | | | | |

2. Behavior Attribute Coding List for 2nd Coding

Coding for Behavior: Experience Mapping (Nominal)

- [0] = no previous CMAPPING experience
- [1] = some previous experience (perhaps mind mapping)
- [2] = extensive previous experience

Coding for Behavior: Context of Participation (Nominal)

- 0 = not at all; 1 = some; 2 = significant
- [0-2] - uses map to aid writing or thinking/doesn't
- [0-2] - uses design features for representation/doesn't
- [0-2] - uses journal activity/doesn't
- [0-2] - meta or self-description of learning with maps/not

Coding for Behavior (Nominal)

- [0] = no premapping*
- [1] = some premapping
- [2] = all premapping

Coding for Behavior (Nominal): Design (Use of Design Features for Meaning Making)

- [0] = not present
- [1] = simple structures
- [2] = extensive complex structures

Coding for Behavior- Transfer (Nominal): Between Mapping & Final Essay - Sampling

- 0 = present ONLY in one or the other; not present at all
- 1 = some elements show up in BOTH (like Green = associational and Purple=)
- 2 = Significant mirroring

* Premapping is distinguished from overall mapping experience in that the premapping refers to the 3 journal entries (#s 5, 6, and 13) assigned to students that asked them to reflectively narrate their mapping processes in a brief audio/visual file.

3. Evaluation Coding Matrix: Transfer Checklist

| | PROCESS JOURNALS | MAP NARRATION JOURNALS | FINAL ESSAY | FINAL CONCEPT MAP |
|-------------------------------------|------------------|------------------------|-------------|-------------------|
| LABEL TERMS: Association | | | | |
| Functional Terms | | | | |
| Relational Terms | | | | |
| Conceptual Terms | | | | |
| DECOMPOSING/RECOMPOSING | | | | |
| Complex (>) | | | | |
| Simple (<) | | | | |
| DESIGNING MOVES: visual/text | | | | |
| Assembling/Constructing | | | | |
| Connecting/Linking | | | | |
| Associating/Generating | | | | |
| Transforming/Restructuring | | | | |
| SYNTHESIS CONTINUUM | | | | |
| Listing | | | | |
| Summarizing | | | | |
| Incorporating | | | | |
| Decomposing & Recomposing | | | | |
| Synthesizing | | | | |

+ Represent using frequency or magnitude coding for correlation?

++ Represent using Presence / Absence?

[US] UNISTRUCTURAL / [MS] MULTISTRUCTURAL / [R] RELATIONAL

4. Master Code List: Triangulation Continuum & Areas of Correlation

| Process Continuum | Developing Processes of Complex Concept Building | Developing Processes of Knowledge Building Practices ¹ | Developing Processes of Structural Knowledge Building | Knowledge Transforming Stages ² |
|-------------------|--|---|---|---|
| ↓ | Assembling/ Constructing | LISTING SUMMARIZING | STRUCTURAL | <i>Knowing That: telling, listing, summarizing</i> |
| ↓ | Connecting/ Linking | INCORPORATING <ul style="list-style-type: none"> ● Discovery ● Functional ● Relational | STRUCTURAL TO RELATIONAL | <i>Knowing How: seeing connections, creating connections</i> |
| ↓ | Associating/ Generating | INCORPORATING <ul style="list-style-type: none"> ● Discovery ● Relational ● Conceptual EARLY D&R <ul style="list-style-type: none"> ● Simple ● Complex | RELATIONAL TO CONCEPTUAL | <i>Early Signs of Knowing Why: grounds for simple conceptual transformation</i> |
| | Transforming/ Restructuring | Complex D&R SYNTHESIS | CONCEPTUAL | <i>Knowing Why: grounds for complex conceptual transformation</i> |

¹ From Segev-Miller's Rhetorical Transforming Strategies ("Cognitive Discourse" 240)

² From Schema theory: declarative, procedural, and structural knowledge (Jonassen et al. 3-4)

APPENDIX B

QUESTIONNAIRE FORMS

PRE-QUESTIONNAIRE SURVEY

1. When asked to write a research paper for school, personal experience and observations are forms of evidence.

| | | | | |
|----------------|-------|--------|----------|-------------------|
| Strongly Agree | Agree | Unsure | Disagree | Strongly Disagree |
|----------------|-------|--------|----------|-------------------|
2. Writing a researched argument essay for a college class is difficult for me.

| | | | | |
|----------------|-------|--------|----------|-------------------|
| Strongly Agree | Agree | Unsure | Disagree | Strongly Disagree |
|----------------|-------|--------|----------|-------------------|
3. I use information from sources even if I am not really sure I understand their ideas.

| | | | | |
|----------------|-------|--------|----------|-------------------|
| Strongly Agree | Agree | Unsure | Disagree | Strongly Disagree |
|----------------|-------|--------|----------|-------------------|
4. When using sources to support my research, I should rely on quotations from library sources, not my own ideas on the subject.

| | | | | |
|----------------|-------|--------|----------|-------------------|
| Strongly Agree | Agree | Unsure | Disagree | Strongly Disagree |
|----------------|-------|--------|----------|-------------------|
5. Making connections between my sources and my own ideas is difficult for me.

| | | | | |
|----------------|-------|--------|----------|-------------------|
| Strongly Agree | Agree | Unsure | Disagree | Strongly Disagree |
|----------------|-------|--------|----------|-------------------|
6. When a teacher asks me to synthesize information during research writing, I understand what synthesis is and how to do it.

| | | | | |
|----------------|-------|--------|----------|-------------------|
| Strongly Agree | Agree | Unsure | Disagree | Strongly Disagree |
|----------------|-------|--------|----------|-------------------|
7. When I am asked to write a paragraph that synthesizes two or more sources, I discover something new I didn't know before.

| | | | | |
|--------|---------|-----------|-------|----------|
| Always | Usually | Sometimes | Never | Not Sure |
|--------|---------|-----------|-------|----------|
8. I find it easy to recognize the similarities and differences between sources I find during research.

| | | | | |
|--------|---------|-----------|-------|----------|
| Always | Usually | Sometimes | Never | Not Sure |
|--------|---------|-----------|-------|----------|
9. I use graphic organizers or maps to help me write my papers.

| | | | | |
|--------|---------|-----------|-------|----------|
| Always | Usually | Sometimes | Never | Not Sure |
|--------|---------|-----------|-------|----------|
10. I use graphic organizers or maps to create new ideas.

| | | | | |
|--------|---------|-----------|-------|----------|
| Always | Usually | Sometimes | Never | Not Sure |
|--------|---------|-----------|-------|----------|
11. Visualizing my ideas using doodling, mind- or bubble-maps, Venn diagrams, or other graphic organizers helps me understand my research topic.

| | | | | |
|----------------|-------|--------|----------|-------------------|
| Strongly Agree | Agree | Unsure | Disagree | Strongly Disagree |
|----------------|-------|--------|----------|-------------------|
12. On a scale of 1 - 5, where 1 is least valuable and 5 is most, rank which is the **most valuable** form of research support (5) and which is the **least valuable** (1):

| | | | | |
|-------------|-----------------|-------------------------|---------------------------|------------------------------------|
| ___ Library | ___ Experiments | ___ Personal Experience | ___ Personal Observations | ___ Information Direct From Source |
|-------------|-----------------|-------------------------|---------------------------|------------------------------------|
13. Short Answer: Which of the above 5 do you use most often as support for your own research papers? Briefly explain why.

POST-QUESTIONNAIRE SURVEY

1. Concept mapping helped me **identify key concepts in my sources**.

Strongly Agree Agree Unsure Disagree Strongly Disagree

2. My concept map helped me **discover new connections to others' ideas**.

Strongly Agree Agree Unsure Disagree Strongly Disagree

3. Using the features of the concept map helped me create new ways to **categorize information**.

Always Usually Sometimes Never Not Sure

4. Concept mapping helped me **recognize relationships** between my ideas and those of my sources.

Strongly Agree Agree Unsure Disagree Strongly Disagree

5. Creating a concept map helped me **write about relationships** between my own ideas and the sources.

Strongly Agree Agree Unsure Disagree Strongly Disagree

6. Creating a concept map helped me **discover new ideas to support my own argument**.

Always Usually Sometimes Never Not Sure

7. Concept mapping helped me **recognize important similarities and differences** between my sources **that reading alone** did not reveal to me at first.

Strongly Agree Agree Unsure Disagree Strongly Disagree

8. Concept mapping helped me **organize my ideas**.

Strongly Agree Agree Unsure Disagree Strongly Disagree

9. Overall, I felt that concept mapping helped me **make my own ideas clearer** when writing my researched argument essay project.

Strongly Agree Agree Unsure Disagree Strongly Disagree

10. Creating a concept map helped me to **better understand the synthesis process**.

Strongly Agree Agree Unsure Disagree Strongly Disagree

APPENDIX C

CONTROL GROUP MATERIALS

1. Letter to Control Instructors

Re: Hoping you'll be interesting in sharing some materials for research in 1020

2 attachments

information-letter_Locklear IRB S2018.pdf; Pre Questionnaire Survey_FINAL Divided.pdf;

Happy Thursday to you all! Thank you again for your willingness to be a part of my research study this Spring. As I mentioned earlier, it's been approved by the AUM IRB board, and will not require you to do any heavy lifting!

So, here are the basics of what I'd be asking from each of you:

1. At regular intervals throughout the semester, please share with me samples of your students' work (3 - 4 students apiece should do) that represent a range of synthesis efforts. You may choose any of your students for this, but I'd ask that they be the same students throughout.

For the first and second samples, if you have your students working in journals or Blackboard to post paragraphs, those would do nicely. But early draft material submitted works too.

For the 3rd and final sample, the full research essay.

In sum: The first sample will be an early sample of student writing, the 2nd will be a sample that represents a bit more time-in-practice with synthesizing source ideas (maybe mid semester), and the 3rd will be their final synthesis work - the finished research paper. (Please remove any identifying student names from these samples prior to sharing with me.)

2. I have drafted a brief, Likert-scale survey to be distributed some time during the first 2 weeks of the semester. Students should only complete and submit the survey AFTER they've received the Letter of Information explaining the purpose of the research study. I'll print plenty of IRB - officially stamped copies for both of these documents, and place bundles in your mailboxes during the first week of classes. The Letter of Information does not require any consent from students -- nothing to sign -- as their individual identities will not be used.

I'm attaching the "unofficial copies" here so you can review -- but please only use these for your own information. The students will need to use the version with the IRB stamp of approval I'll place in your boxes. Perhaps the survey will be useful to you in your own lessons as it is designed to elicit student reflections on their experience with research paper writing. These surveys are anonymous so no names need be scrubbed. In the packets I place in your mailboxes, I'll include a brief memo of overview.

And that's it! If you'd like more details on the study itself, I'm happy to chat or email about it! Thanks again for your help with this!!

Amy Locklear
AUM Distinguished Lecturer in Composition
Department of English & Philosophy
Auburn University Montgomery

2. Control Assignments

Unit 3 Assignment

Assignment 3: Project Outline & Purpose Reflection Description:

As this class is about the process of writing, you'll need to consider your choices of source material from Unit 2 and your annotated bibliography as you begin organizing your paper. Your preliminary reading and research into your annotations gave you the chance to think critically about the material you are using to build your argument as you join the larger conversation about your chosen topic.

For this assignment, you will create an enhanced outline draft that will guide your reader through the rationale behind your paper. Think of this outline as a map of your paper. It is supposed to be much more than a bullet-point outline. It will have full sentences that will work to build your research ideas and argument. You will use full, descriptive sentences that can work as part of your draft for Unit 4. This is where you will start bringing in supporting evidence and quotations from the sources you have been collecting and reading.

Each portion of this outline will serve a specific purpose. Your introduction will inform your audience of your subject and your specific point of this research. It will also tell why this is an important subject to consider. From there, each body paragraph will show each point of your argument, as well as the evidence that supports your claim. These are your "so what" or "because" points. Here, you will use quotations (appropriately cited) from your sources, along with your own words to further your argument. Make sure that you continue to state why this research is important, and the purpose it fills.

Your thinking should be the major component of this assignment, highlighted by the outside sources you are pulling from. This is not the place to stack quote upon quote. YOU need to be in this work. This assignment should be a MINIMUM of 4 pages. If your work is that short, it best be GOOD. By that, it should show that you have fully engaged with your source material, have good quotes pulled, and your organization should be spot on.

Unit 3: Outline And Annotated Bibliography

There are many ways to organize an argumentative essay. Maybe you need to explain a step-by-step process or sequence. You might discuss a problem and solution, and then refute counterarguments or alternative solutions. Or perhaps you will begin your essay with the antithesis and then present your own argument. You should determine which one works best for your project and why it is the best method for conveying your message.

This assignment consists of two parts: an **outline** (with a **reflection**) of your final research paper and an **annotated bibliography** containing all **six sources** that you plan to use in your final paper. Your **outline** should be organized using the alphanumeric style seen in the Sample A Paper in the Unit 3 folder on Blackboard, with Roman numerals representing paragraphs, capital letters representing major points within those paragraphs, Arabic numerals representing sub-points to the major points (this would be a good place to insert quotes, paraphrases, and summaries from your sources), and lowercase letters breaking down those sub-points even further if necessary. Your introduction should end with a clearly labelled, complete sentence thesis statement. There is not a set number of points or sub-points that you are required to write; write only what is necessary to convey your argument. In other words, use your judgment to determine how many points and sub-points are necessary as the same formula will not always work for every writer and every topic.

That is where your **reflection** comes in. The reflection is your opportunity to justify the decision you have made in your outline. Beneath each section of your outline (as represented by a Roman numeral), you should write one paragraph explaining the choices you have made for that portion of the outline. Why are you beginning your essay with this kind of a hook? Why have you chosen this thesis statement? Why are you using a particular quotation, paraphrase, or summary here? In other words, what do these choices add to your argument?

Finally, your **annotated bibliography** should be formatted like your complex source evaluation. List the **bibliographic information** for each source followed by a **single paragraph** explaining what the source is and how you intend to use it. You do not need to evaluate the sources this time. At least three of your six sources should come from the AUM library catalog or databases or from your *Funny* textbook. You should identify each source's BEAM Model classification in the annotation. You do not have to cover every source type from the BEAM Model, nor is there any particular limit on the number of times you can use a single type of source. That being said, diversity in source types is encouraged.

Unit 4 Assignment

Unit 4: Argumentative Research Essay

It's finally time to join the conversation. For your final major writing assignment, you will write an argument that is supported by evidence from your background sources while engaging with supporting and opposing sources by responding to quotes, paraphrases, and summaries of the ideas, information, and arguments within those sources. There is no single correct way to write this paper, but these are some basic guidelines you should follow.

- ✓ **Introduction:** You might begin with a hook such as a quotation, anecdote, or shocking statement in order to grip readers. You should include a thesis statement, your argument on the issue. This is also a good place to frame the issue, though you might include background information in the body as well. Your introduction could comprise multiple paragraphs if you deem it necessary.
- ✓ **Body:** Body paragraphs comprise the meat of your entry into the conversation as that is where you will engage with sources and provide evidence to support your argument. Never begin or end a body paragraph with a quotation, paraphrase, or summary. Lead into them, then respond to them.
- ✓ **Conclusion:** Your conclusion (which, like the introduction, can be more than one paragraph) can serve a number of purposes, but reiterating your essay should not be one of them. Instead, explain why your argument is valid while counterclaims are less valid. You might call your readers to action to solve a problem, and you might refer back to your introductory hook. Perhaps you want to speculate about the future, both if society were to adopt your ideas, or if the world were to continue in its current direction or an opposing one. The conclusion is your chance to leave readers with a final impression.
- ✓ **Works Cited Page:** You don't need to annotate your sources this time, but you should have a page (or two) at the end of the paper listing all six of your sources in MLA 8th edition. As with previous assignments, see Purdue OWL for assistance.

Assignment 4: Final Project Description:

This is your final project for the class, but, in reality, this is the project you've been working on since day one. This culminating project is the research argument we've discussed since the beginning of the semester. All of the units and assignments have been building to this paper. Essentially, your project needs to make a clear argument and back it up with sound research.

You will compose an 8-10 page academic argument that is appropriate for the audience you selected earlier in the semester. Remember our work on the rhetorical situation and decide your role as an author, your overall purpose, and your audience. Then, present your message in light of these ideas. Remember the rhetorical tools you have at your disposal, including appeals to ethos, pathos, and logos.

Your paper will include a minimum of eight (8) outside sources, five (5) of which must be scholarly (peer-reviewed). What that means is that there will be eight (8) entries in your Works Cited, and that I should be able to find all eight (8) works represented somewhere in your paper. You may have up to 10 sources.

This paper shouldn't flag for more than 30-35% in Turnitin. If it does, that tells your audience that you've relied too heavily on your sources and not enough on your own voice and argument.

Your final product will be graded on how well you present your argument to this audience. In each paragraph, I will be taking on the role of a reader in the audience you select and will evaluate you on the effectiveness of your argument and your credibility as an author and researcher.

Remember that correct grammar and punctuation are essential to maintaining this credibility, as well as a clear and concise argument that stays focused on your message and rhetorical purpose.

APPENDIX D

INTERVENTION INSTRUCTION MATERIALS

1. Map Instructions Handout

Basics of Concept Mapping: Key Terms and Features

14
December

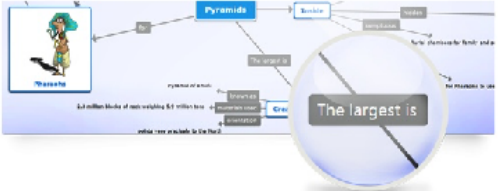
Concept Mapping Reimagined

Posted in [Announcements](#), [Features](#)

It's that time of the year that calls for making gifts and celebration. Speaking of which, we got you a present. Something special that will let you:

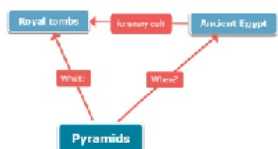
Label the lines between topics

Whenever you add a new topic in your concept map, you can instantly explain how it's linked to the previous one. Your maps will make perfect sense both for you and the people you share them with.



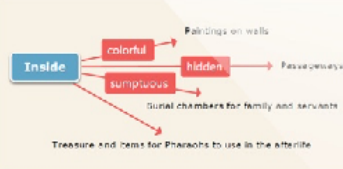
Create multiple connections between topics easily

As your map builds up, you'll probably see connections you didn't think before. So click on a topic, drag the connecting line and drop it onto the linking topic. Once you label it, your new connection is out in the open.



Position topics freely

Build your concept map without any layout restrictions. Topics can be easily moved anywhere on the map canvas simply by dragging them. Organize your map as you see best.



Yes, you got it right, we reimagined concept mapping for you. That's because we wanted to thank you for your constant support and for staying with us in the long run. Enjoy your holiday and see you in 2016!

Keep it smart, simple and creative!
The Mindomo Team

Concept Map

Basically, there are only 3 “moving parts” in a concept map. They are the:

Node: the rectangular shaped boxes that serve as your main ideas or “topics”

Connecting Line or Link: the directional arrow lines you draw from one node to another

Label: the text box found on every Connecting Line or Link. Phrases and words in this box describe the reasoning behind making this connection (typically a one- to two-word noun or verb phrase)

Use these features to construct & show concepts, topics, and relationships between them, as well as a map of your reasoning (how it all fits together to “make meaning” from the individual parts)

Visit the Mindomo Help Tutorials at this web link for more:

Creating a Concept Map:

<https://youtu.be/-OjmaUF7Lkc?t=20s>

See The Full Playlist of Mindomo Tutorials:

<https://www.youtube.com/playlist?list=PLOWUIX-xhRIIRCItrbJRxSjoW217ceQ3>

2. “Function of Our Maps” Handout

Handout
week 9

The Functions of Our Map Features (see earlier handout “Why Are We Using Concept Maps?”)

It’s all about the **synthesis of concepts and ideas**; How we **represent** our logic and reasoning

- Think: RELATIONSHIPS, ASSOCIATIONS, PATTERNS - these become the markers of where we can begin to **synthesize (REMIX)**
- How do we express these as part of working our sources into our argument?
- These graphic elements allow us to demonstrate how we make sense of these connections & relationships (“making meaning”)

NODES: These are our ideas, our concepts, and also others’ ideas (the sources we add to our conversation while building the logic and reasoning of our argument)

CONNECTOR LINES: These are markers of the relationships and patterns and associations we are discovering as we develop our reasoned argument.

DIRECTIONAL ARROW: The direction you draw these connector lines SIGNALS a connection and the LOGIC of your reasoning. This points to how you see these nodes building from one to the other as the relationship of ideas - how one CAUSES, LEADS TO, RESPONDS TO, IS RELATED TO, etc.

CONNECTOR LABELS (BOXES): These brief verb / noun words or phrases capture the NATURE of these relationships, as well as your understanding of HOW THESE FIT TOGETHER according to YOUR understanding of the argument you’re mapping.

GRAPHIC ELEMENTS: There are several choices here, all of which allow us to **represent** how our sense of logic and construction of meaning is happening.

- **Color Coding** nodes allows us to “see” the patterns of categories of information, ways we might put materials together to support an idea.
- **Images & Video clips** allow us to represent these ideas and connections in visual ways, like creating a metaphor to represent a difficult concept or connection. They can also serve as illustrations or examples of how we are developing our reasoned argument.

3. Synthesis Vocabulary List Handout

LINKING PHRASES / VERBS: Labels That Lead To / Signal **Synthesis** Thinking: Vary these terms or phrases to fit your sentence grammar. The important thing is to consider your answer to the question: *How do I want to position these voices and their materials into conversation with each other AND with you?*

| To Show Addition / Cumulative At Work | To Show A Comparison At Work | To Show Exception; Contradiction | To Show Time; Chronological Connections | To Show Repetition |
|---|---|---|---|---|
| Again; Besides; Equally important; Further; Furthermore; Too; Next; Lastly; Moreover; In addition; First / Second / etc.; Confirmed by; Overlap(ping) | But; Yet; On the other hand; Although; However; Nevertheless; On the contrary; Meanwhile; But; By comparison; Compared to; In contrast; Although this may be true | Yet; Still; However; Nevertheless; In spite of; Despite; Of course; Refutes; An alternative to | Finally; Then; Previously; Formerly; First - Second - etc.; Next; Furthermore | As has been noted; As has been argued; Similarly; In the same way; This is affirmed by; Like; This resembles; This is comparable to |
| To Emphasize | To Give Examples | To Summarize or Conclude | To Show Sequential Relationships | To Show Cause / Effect |
| Obviously; In this case; This is reinforced by / when; Similarly; Equally; As important; Explains | Another example of this; In another case; In this situation; This is illustrated / demonstrated by; Such as; Expressed in | This is summarized; Therefore; A result of this; This demonstrates; Supported by; Drives | First/Second/Third; etc.; Then; Subsequently; Consequently; Before this; Simultaneously; A result of this; Expressed in; Predicts; Explains | Results in; Similarly; Therefore; This leads to; This results in; A result of this; Provides; Determines; Predicts; Gives |
| Using Active Verbs To Label Reasoning & Relationships. Think of this as the "syntax" of establishing and steering the conversation. "How does this material function? What does it DO? How does it...Make a Claim; Express Agreement or Disagreement; Make Recommendations?" | | | | |
| Making a claim: argue, assert, believe, claim, emphasize, insist, observe, remind us, report, suggest | Questioning or Disagreeing: complain, complicate, contradict, question, reject, repudiate | Agreeing acknowledge, admire, endorse, agree, praise, reaffirm, support, verify, confirms, answers | Recommending call for, demand, encourage, implore, plead, recommend, urge, warn | |
| Other verb choices that "label" your reasoning, the connections you want to show in your reasoning (and in your visual map of that reasoning) | | | | |
| Proves | Points to | Debates | Defines | Causes |
| Solves | Evaluates | Values | Improves upon | Responds to |
| Centered on | Connects to | Includes | Drives / Adds to | Determines |
| Requires | Uses | Helps | Begins With | Shows |

4. Unit Assignment Sheets 1-3

ASSIGNMENT STAGE 1

EXPLORING THE CONVERSATION: DEVELOPING YOUR RESEARCH Q & PROPOSAL

Every successful research project begins with exploration and inquiry. As part of laying the groundwork for later projects, this first assignment is designed to help you **identify a topic** that lends itself to one or more arguable issues you might want to **explore** more deeply through this semester's research activities. Taking the time to explore a topic, through writing, makes us examine issues that we find interesting and find potential angles (as well as other opinions) that are relevant and arguable beyond simply "Because I said/think so." Keep in mind that you are not bound to this topic for the entire semester; indeed, I expect your thinking to change over the course of these coming weeks. However, as our course is designed to acquaint you with the **habits** of research writing as **conversation**, as well as critical thinking and persuasive argument, we must have a place to begin. This Unit asks you to think about how you will enter the conversation by helping you create a **Research Question**. Learning how to ask an effective Research Question leads to potential Research Answers, what we'll call a **Research Proposal**. This Proposal is an opportunity for you to prepare a plan of action early in your research process. Research Proposals force us to move beyond our initial enthusiasm at having found a potentially interesting idea, and on to the bigger picture of whether that idea can become a solid, supportable argument.

Your essay will be composed of two parts:

Part I: In approximately **two double-spaced pages (about 600 words)** of content, identify and explore a concept or topic you consider interesting enough to inspire deeper exploration, and one you might consider suitable for your semester's research efforts at this point. This is your "Idea Discussion" in which you will **explore** what you see as some of the ideas, arguments, and concepts surrounding your topic. Read Wikipedia. Do a basic Google search. Explore, in writing, the arguments that surround the topic. Beginning with preliminary observation activities and the information drawn from in-class worksheets, **expand** your ideas into a **discussion** of your interests in that topic. Your discussion should identify potential **directions**, **variations**, and **contexts** related to your selected issue. For example, what is the subject of the discussion and what types of **stakeholders** might be interested? What are some of the ideas, concepts, and arguments that surround the topic? This sets up the context and reasoning behind your anticipated exploration and research.

Part II: This section will be a brief explanation of the work you need to do to get to the next phase of this assignment, mapping out what you hope to accomplish with your research and discuss why your audience should or might be interested in it. What questions do you need to ask / answer, and how do you plan to answer them? What types of research do you require, and how will you proceed? The goal of this section is to help you think about **how** you want to enter the conversation by first creating one or two **Research Questions**. Learning how to ask an effective Research Question leads to potential Research Answers -- a **Research Proposal**. This Proposal is an opportunity for you to prepare a plan of action early in your research process. Research Proposals force us to move beyond our initial enthusiasm at finding a potentially interesting idea, and consider the bigger picture of whether that idea can become a solid, supportable argument.

ASSIGNMENT STAGE 3

MAP YOUR ARGUMENT: PROJECT OUTLINE & ANNOTATED BIBLIOGRAPHY

The last unit gave you a chance to think critically about some of the materials you will need to develop your own argument as part of a larger conversation. This Unit asks you to begin **mapping** the structure and logic of your ideas, your claims, and your support. A significant part of this project is the **visual map** you have been creating using the digital concept mapping program **Mindomo**. For this assignment, you will create **a complete Mindomo map** of your emerging argument's logic, which you will use as the basis for a **4 page outline-narrative** that guides the reader through your map, providing the rationale and general order for your researched argument ideas. The final piece of this assignment will be an Annotated Bibliography of a minimum of 10 sources that extends the work done for assignment 2. (You can draw from the last unit's Bibliography - just be sure to make any appropriate revisions to format and content to suit this assignment's guidelines.)

This unit will consist of 3 parts: (1) a narrated outline of your ideas & strategies for development, (2) an Annotated Bibliography, and (3) a concept map. The 1st part is rather like a hybrid of outline and narrative, based on your argument's visualize structure (Mindomo map). It is designed to help your reader better understand the purpose and connections behind your rhetorical choices evident in the map as you begin to pull together the fruits of your research. For example, if your map includes a quote as part of your introductory sections, your narrative should let the reader know *why* it serves a specific purpose (such as alerting the reader to the significance of a problem). Such **reflective narrative** serves as a guide to your thinking, making your reasoning visible, and your plans (even if they are not yet finished) explicit. Think of this as giving your audience a guided tour of your map, one that includes lots of insight to your decisions involved in designing this map.

Content Guide:

PART I: This is your narrative, a "talking draft" of your emerging research essay. Included: a working title, intended strategy for introducing your paper, a working thesis statement, how you will organize your support (background, competing perspectives, and perspectives in agreement with their topic), and the intended concluding strategy.

ASSIGNMENT STAGE 4

FINAL RESEARCHED ARGUMENT

At last, all of the hard work of the previous stages now combine in this final essay. This is your final project for the class, but, in reality, this is the project you've been working on since day one. This culminating project is the research argument we've discussed since the beginning of the semester. All of the units and assignments have been building to this paper. Essentially, your project needs to make a clear argument and back it up with research.

This will be an 8-10 page academic argument that is appropriate for the audience you selected earlier in the semester (your "stakeholders" and discourse community). Remember our work on the rhetorical situation and decide your role as an author, your overall purpose, and your audience. Then, present your message in light of these ideas. Remember the rhetorical tools you have at your disposal, including appeals to ethos, pathos, and logos.

Your final project will be graded on how well you present your argument to this audience. In each paragraph, I will be taking on the role of a reader in the audience you select and will evaluate you on the effectiveness of your argument and your credibility as an author and researcher.

Remember that correct grammar and punctuation are essential to maintaining this credibility, as well as a clear and concise argument that stays focused on your message and rhetorical purpose.

Details: This final assignment requires you to (1) utilize the information literacies you have developed throughout the semester; (2) select and engage meaningfully with multiple sources; and (3) organize, analyze, and synthesize information from these sources to develop a **persuasive** argument that reflects your voice and informed point of view. Driven by an arguable thesis that reflects a complex claim about your identified course theme-related issue, your essay will follow and enhance the outline you created in the previous stage, as well as clearly benefit from the reasoning and analytical evaluation from the first two projects. Moreover (and perhaps most importantly as a conversation), you will need to successfully engage with and combine information drawn from sources with your own ideas to coherently and logically develop and support your thesis claim. This will be your original contribution to the ongoing **conversation**.

To write an effective researched academic argument, you must pay particular attention to the very important rhetorical element of **Audience**. Therefore, this assignment will shift to the formal academic voice typically expected by an Academic community. But to help make this "real," we'll frame these final units in a real-world scenario in keeping with our metaphor of **conversation**. Therefore, envision yourself as a participant at a professional conference focused on your selected topic, attended by a room full of interested stakeholders. Imagine this conference is focused on exploring and debating a wide variety of perspectives on this issue in order to raise awareness and problem solve.

Keep in mind that envisioning this assignment as a presentation is going to influence your writing in significant ways. For example, how can you best guide your Readers? How will you gain your listeners' attention? You certainly don't want to bore them. Perhaps using *pathos* in an introduction would be advantageous. How should you introduce the outside sources you use in order to convince your audience that these sources (your conversation partners) are credible and effectively illustrate the points you want to make? You have before you an informed audience, so the concept of *ethos* comes into play. Are you drawing upon other experts to help you make your argument? Can the audience easily distinguish what it is **you** are bringing to this argument from all these other sources? They want to know what **you** have to say about an interesting and important topic. They don't want you to merely string together a lot of quotations and repeat what others have already said without some original *transformation*. Considering these rhetorical exigencies and situations should help you consider how best to develop your project in a way that advances your ideas as a contribution to a complex topic in the most effective, influential way.

Something you might want to consider as you finalize your ideas is the use of **visuals**. Perhaps your argument could benefit from charts or graphs, photos or film clips, or PowerPoint slides. You might even design a short handout (an annotated bibliography or a list of web sites your listeners might want to visit in order to learn more about the topic) that could serve as an Appendix in a written document. Of course, you are not required to include slides, images, or an Appendix with your written argument. Just keep it open as an option. Such thinking will help you think of how to best illustrate and support your claims to best persuade your audience. (It will also benefit your final exam planning.) *Keep in mind, however, that graphic elements do NOT count toward the required page length!*

5. Journal Posts: #s, Content, & Date

| | | |
|--|----------------------------|------------------------------------|
| 1. Sample Writing about tech | Agency | Week 2: Jan 14 |
| 2. About Experiences w/ Concept Mapping | Map Related | Week 3. Jan 21 |
| 3. Preexisting knowledge about your topic | Agency | Wk 4. handout on "Fct of CMAPs" |
| 4. 1st synthesis of sources Contrera/Davidson | Synthesis related | Wk 5: Feb 4 |
| <u>5. 1st Narrated CMap</u> | Map Related | Wk 6: Feb 18 |
| <u>6. 2nd Narrated CMap</u> | Map Related | Wk 9: Mar 4 Synthesis Term Handout |
| <u>7.</u> In class synthesis prewrite - scaffolding | Synthesis related | Wk 10: Mar 25 |
| <u>8.</u> Out of class synthesis prewrite | Synthesis related | Wk 10 |
| <u>9.</u> Mindomo & Represent Image | Map & Synthesis | Wk 11. Apr 1 |
| <u>10.</u> In-class synthesis SIEL parag | Synthesis related | Wk 11 |
| <u>11.</u> Meme (dropped) | | |
| <u>12.</u> Counterargument parag | Synthesis | Wk 12. Apr 8 |
| <u>13.</u> <u>3rd Narrated Cmap</u> | Map Related | Wk 12 |
| <u>14.</u> Draft | Synthesis | Wk 13. Apr 15 |
| <u>15.</u> CMAP Design Choices (inclass) - 1st look | Map Related | Wk 13 |
| <u>16.</u> CMAP Reflection - stages | Map Related | Wk 14. Apr 22 |

6. Narrated Map Prompts (NP1–NP3): Mindomo Concept Map Progress Posts

WEEK 6— 2/14

Mindomo Narrated Post #1: Talk through your early map elements, including nodes for:

1. Your chosen topic
2. Your main research question or questions (these should be worded in ways that incorporate one or more of our claim vocabulary words - cause, effect, problem, solution, definition, value, policy. Doing so leads us to ask questions that invite argument, differences of opinion)
3. Your answer to that research question in the form of an “I Believe” opinion
4. Several “I believe because” nodes that provide **different supporting reasons** for that belief. These will be what your research will illustrate and support
5. Connector lines. Think of these as directional signs that represent what you want to connect—the boxes on the lines capture WHY you make that connection, in what direction you are pointing (think “cause and effect”).
6. 3 - 6 source nodes, not yet connected to any other node.
7. Some color coding or multimedia elements may also be included at this point—you’ll talk more about these choices in the 2nd Narrated Post.

Mindomo Narrated Post #2 (WEEK 9): This post should explain your cross-connections in your map. Explain WHAT connections you drew, WHY you connected these nodes (include comments on the choice of arrow direction as well, maybe consider adding color coding to the nodes to further show their relationship). You also want to explain your choice of the connector label language . . . what does the verb or noun phrase you inserted in the connector box explain about the way you see the relationship between the nodes and what that has to do with designing the support of your thinking & argument.

Mindomo Narrated Post #3 (WEEK 13):

Pre-Step Prompt 3: Visualize

Another element of your concept mapping includes relevant and related visual elements. These visuals include images, short video clips, and hyperlinks to web sites. Think about the many ways we use visual literacy to help us express concepts or emotions: Emoji, memes, Vines, etc. Every time you read a web text that embeds a hyperlink, like this, that’s also a visual literacy. Translated, it roughly means “go to this web page for more information about this highlighted term.” Our Mindomo maps are already one level of visualizing our ideas; adding additional images takes that a step further to capture some of our creative, outside-the-box thinking that represents OUR view of the subject matter.

PROMPT: (Part 1) PICK one idea in your Mindomo map/argument development you’re having trouble expressing using written text. Find a video, music clip, an image, or a meme/gif/cartoon that you feel really captures the point you’re trying to make. Add that to your Mindomo map and connect it to the point or source where you feel it fits and expresses the meaning you’re trying to make. Next, in a paragraph, explain what that visual means to your ideas (what point or idea does it illustrate?). How does that media help you create the LOGIC or PATHOS of that part of your argument? (Be sure to mention where it fits in your argument structure.)

PROMPT: (Part 2) Narrated MINDOMO JOURNAL. This one isn’t due until 5 PM on Monday 4/9: Capture an image of ONE PART of your map, a part that you feel really develops one of your main ideas. Talk about how the act of mapping this part of the map shows the development of your thinking about this main supporting point, the issue’s importance, and how your thinking, connections, understanding have changed from early map/early thinking to current map/current thinking. What has changed? What hasn’t? Where do you SEE your thinking and understanding grow, change? You could also talk about how this part of the map and the map tools do NOT help you see/connect/understand/grow.

APPENDIX E

IRB MATERIALS

1. IRB Approval, Auburn University-Montgomery



AUM IORG #: 0005227
AUM IRB #: IRB00006286
FWA#: 00012889

Date: December 6, 2017
To: Amy Locklear
 English and Philosophy Department
 College of Arts and Sciences
From: Dr. Glen Ray, IRB Chair
Re: Approval of Modification, "*A Grounded-Theory Case Study of Concept Maps & Synthesis Writing in Freshman Composition II*"
 IRB file #2018-04

Thank you for submitting your revisions to the IRB for review. Given the nature of your research, this proposal is approved under the review criteria of *Category 7* of the **Expedited** review process as cited in *45 CFR 46.110 (Code of Federal Regulations)*:

Research on group characteristics or behavior (including, but not limited to, research on perception, cognition, motivation, identity, language, communication, cultural beliefs or practices, and social behavior) or research employing survey, interview, oral history, focus group, program evaluation, human factors, evaluation, or quality assurance methodologies.

ADDITIONAL NOTES:

- Use only copies of the survey and consent forms with the IRB approval stamp.
- Do not make any changes to your research protocol. If you need to make changes please halt your work and send the request/s to the chair of the IRB for further review (using the *IRB Request for Modification*.)
- If individuals are added to your research team they will need to complete CITI training. Also, an *IRB Request for Modification* should be completed to record the addition of this team member to your project (by name) and sent to this office.

AUBURN UNIVERSITY AT MONTGOMERY
 Institutional Review Board
 P.O. Box 244023, Montgomery, AL 36124-4023, 334.244-3250, www.aum.edu

2. Letter from Old Dominion University, Exempt Status Approved



OFFICE OF THE VICE PRESIDENT FOR RESEARCH



Physical Address

4111 Monarch Way, Suite 203
Norfolk, Virginia 23508

Mailing Address

Office of Research
1 Old Dominion University
Norfolk, Virginia 23529
Phone(757) 683-3460
Fax(757) 683-5902

DATE: March 10, 2016

TO: Amy Locklear

FROM: Old Dominion University Arts & Letters Human Subjects Review Committee

PROJECT TITLE: [873462-1] ENGL840 Concept Maps and Synthesis

REFERENCE #:

SUBMISSION TYPE: New Project

ACTION: DETERMINATION OF EXEMPT STATUS

DECISION DATE:

REVIEW CATEGORY: Exemption category # [6.1, 6.2, 6.4]

Thank you for your submission of New Project materials for this project. The Old Dominion University Arts & Letters Human Subjects Review Committee has determined this project is EXEMPT FROM IRB REVIEW according to federal regulations.

We will retain a copy of this correspondence within our records.

If you have any questions, please contact Randy Gainey at 757-683-4794 or rgainey@odu.edu. Please include your project title and reference number in all correspondence with this committee.

This letter has been electronically signed in accordance with all applicable regulations, and a copy is retained within Old Dominion University Arts & Letters Human Subjects Review Committee's records.

3. Consent Letter Distributed to All Student Participants

INFORMATION LETTER
Concerning Participation in a Research Study
Auburn University at Montgomery

PROJECT TITLE: A Grounded-Theory Case Study of Concept Maps & Synthesis Writing in Freshman Composition II

Description of the research and your participation

As students enrolled in an AUM English 1020 course, you are invited to participate in a research study conducted by Amy Locklear. The purpose of this research is to explore student synthesis writing practices and any possible benefits of concept mapping in student research writing.

Your participation will involve only activities already described in the course syllabus and other materials, such as: writing journal entries and draft work related to your research, work in Mindomo concept maps (for some groups), and final research essays. Each journal entry sampled for the study will consist of short passages that synthesize two (no more than three) at a time of your conversation partners (sources) following the guidelines of our textbook and course materials. This is the same amount and type of work laid out by our syllabus, so you will not be doing any additional work if you consent to be a part of the study. At the start and end of the term, you will be asked to complete an anonymous survey about your experience with research writing and concept mapping - a proctor will deliver these surveys and collect the forms to preserve participant anonymity. After all course grades have been submitted to Webster in final form at the end of the term, a sampling of students' final research projects will also be examined for markers of synthesis writing.

The amount of time required for your participation will not exceed the duration of the course, following preexisting lesson plans and schedule. There will be no additional work or time required above and beyond what the course syllabus outlines.

Risks and discomforts

There are sometimes risks or discomforts associated with research. They include the possibility of breaches of confidentiality and possible feelings of coercion. However, to avoid these, student materials gathered as part of this research study will **only** be seen by the course instructor, and student names on all materials will be replaced with pseudonyms. Materials will only be examined for the study after grades have been posted, so participation in the study will have no impact at all on your assignment grades. The surveys will be distributed by a proctor (another AUM staff member) to maintain your anonymity - the instructor will have no way to connect student names to the survey forms.

Potential benefits

This research may help us to understand student research writing practices and the influence of concept mapping on student research ideas. It may also help you with your own research assignments for this and other courses.

Auburn Montgomery
Institutional Review Board
has approved this document for use
from 12-6-2017 to 12-5-2018
Protocol # 2018-04

4. E-Mail Correspondence with Dr. Segev-Miller: Permission to Use Continuum

From: Dr. Rachel Segev-Miller
Sent: Friday, August 2, 2019 1:40 AM
To: Amy Lee Locklear
Subject: [EXTERNAL] Re: Contact through ResearchGate regarding your work on Discourse synthesis

Dear Amy,
You wrote:

I am at last in the writing stage of my Dissertation work
Great!

(on the subject of Synthesis as Cognitive Process, using concept mapping as an intervention in a university freshman writing course). In preparing my study, I found your work on discourse synthesis incredibly helpful, and in particular your synthesis continuum tool from your own study of student writers, *Cognitive Processes in Discourse Synthesis* (1997).

Have you read my 2007 chapter in [Writing and Cognition: Research and Application?](#)

I am writing to request your permission to incorporate this tool as part of my dissertation, with full citation of course

You have my permission to do so, of course.

I'd love to read your dissertation once you've finished writing it.

Good luck,
Rachel

Dr. Rachel Segev Miller
The MOFET Institute,
Tel-Aviv, Israel

VITA

Amy Lee Marie Locklear
Department of English
Old Dominion University
Norfolk, VA 23529

Old Dominion University Ph.D. in English—Rhetoric Writing and Discourse, Technology and Media Studies
Norfolk, VA
December 2020

Auburn University MA in English—Rhetoric and Composition
Auburn, AL
2003

The College of William and Mary in Virginia BA in English
Williamsburg, VA
1987

Amy Lee Marie Locklear is a Distinguished Senior Lecturer for the English and Philosophy Department's Writing Program at Auburn University at Montgomery. She teaches first-year and upper-division writing courses (online and face-to-face), as well as Honors Program freshman seminars. She has presented at numerous national conferences including Conference on College Composition and Communication, the Thomas R. Watson Conference on Rhetoric and Composition, and the Georgia International Conference on Information Literacy. Her paper "A Proposed Redesign of the Research Arc of Freshman Composition" was published in *The Journal of Teaching & Writing* in 2016.