

University of Arkansas, Fayetteville

**ScholarWorks@UARK**

---

Graduate Theses and Dissertations

---

12-2021

## Does Self-Reference in Concept Mapping Influence Transfer?

Daniel A. Parker

*University of Arkansas, Fayetteville*

Follow this and additional works at: <https://scholarworks.uark.edu/etd>



Part of the [Adult and Continuing Education Commons](#), [Educational Assessment, Evaluation, and Research Commons](#), [Educational Methods Commons](#), and the [Educational Psychology Commons](#)

---

### Citation

Parker, D. A. (2021). Does Self-Reference in Concept Mapping Influence Transfer?. *Graduate Theses and Dissertations* Retrieved from <https://scholarworks.uark.edu/etd/4344>

This Dissertation is brought to you for free and open access by ScholarWorks@UARK. It has been accepted for inclusion in Graduate Theses and Dissertations by an authorized administrator of ScholarWorks@UARK. For more information, please contact [scholar@uark.edu](mailto:scholar@uark.edu).

# Does Self-Reference in Concept Mapping Influence Transfer?

A dissertation submitted in partial fulfillment  
of the requirements for the degree of  
Doctor of Education in Adult and Lifelong Learning

by

Daniel A. Parker  
Arkansas State University  
Bachelor of Arts in History, 2010  
City, University of London  
Master of Science in Information Science, 2011

December 2021  
University of Arkansas

This dissertation is approved for recommendation to the Graduate Council.

---

Kevin M. Roessger, Ph.D.  
Dissertation Director

---

Michael S. Hevel, Ph.D.  
Committee Member

---

Christine E. Holyfield, Ph.D.  
Committee Member

## **Abstract**

Concept maps are a popular learning activity that have successfully demonstrated student learning outcomes. Research suggests that concept mapping has a positive effect on recognition, recall, and transfer. Likewise, researchers in cognitive psychology have shown the value of referencing oneself with a concept. Known as the self-reference effect, learners who connect their experiences or traits with new knowledge are more likely to remember that knowledge than if they used other mnemonic devices. Previous research suggests that integrating self-reference in concept mapping may improve recall. However, to date, no study has investigated the influence of this combination on higher order learning outcomes, such as transfer. In this study, I ask whether self-reference in concept mapping improves learning transfer. Using a segmented repeated measures design, I collected transfer scores across eight time points. Participants completed a concept map on a topic, followed one week later by a written assignment asking participants to apply that topic. After the fourth measure, I asked participants to reference themselves in their concept maps. Using a Generalized Estimating Equations (GEE) model, I found a significant positive interaction in transfer over time after the intervention. However, after the intervention, there was no immediate effect, suggesting that practice and feedback are essential components of self-reference in concept mapping.

©2021 by Daniel A. Parker  
All Rights Reserved

## Acknowledgments

Anyone who has ever met a doctorate student knows that completing a dissertation is no simple feat. Students, if we are lucky, have people who have helped us along our journey, either directly or indirectly through material or emotional support. I am no different.

Throughout planning, reading, research, and writing, I have had significant help along the way. I am deeply indebted to my supervisor, Dr. Kevin Roessger, for his assistance in formulating questions, brainstorming research designs, and his guidance with analysis. It was his—along with Drs. Barbara Daley and Duaa Hafez—2018 study on feedback and practice with concept mapping that inspired this study. Additionally, I am grateful for his mentorship, career advice, encouragement, and moral support, and for showing me the value of science in adult learning research. For some, a dissertation supervisor instills fear, dread, or other emotional distress. For others, a supervisor is simply another procedural aspect of the doctoral program. I am fortunate that Kevin has not only been a great supervisor but a wonderful friend who has made a tremendous impact on my research and career path. Additionally, I would like to thank Drs. Michael Hevel and Christine Holyfield for their feedback, guidance, and patience throughout the process. I doubt I could have a better committee, and I am grateful for their service.

I cannot begin to express my thanks to my wife, Leslie. Throughout my studies, she has made significant sacrifices and demonstrated a tremendous amount of love. She provided support when I decided to take a graduate assistantship and tolerated a long-distance relationship. During times of stress, anxiety, depression, elation, confidence, and the myriad of other experiences common to the dissertation process, she has stood by me. Additionally, I thank my colleagues at *Adult Education Quarterly*, Drs. Elizabeth Roumell and Ellen Boeren, for their encouragement

and support. I also want to briefly acknowledge James Cox, Andy and Megan Ray, Benjamin Pipher, and Jonathan Cox for helping me to explain my study to an audience outside of my field, and most importantly, for the much-needed distractions. Finally, I would like to thank Regina Moore for launching my career in education and leading me down this path.

## **Dedication**

I dedicate this dissertation in memory of my brother, Jake Morrison (1981-2020).

Thank you for always sparking my curiosity.

## Table of Contents

Chapter 1 – Introduction .....	1
Overview .....	1
Background of Study .....	3
<i>Concept Mapping</i> .....	3
<i>Self-Reference</i> .....	6
<i>Learning transfer</i> .....	8
Need and Purpose .....	10
Definitions .....	11
<i>The self-reference effect</i> .....	11
<i>Transfer</i> .....	11
<i>Concept</i> .....	11
<i>Concept Map</i> .....	12
<i>Proposition</i> .....	12
<i>Cross-link</i> .....	12
<i>Concept Map Scores</i> .....	12
<i>Adult Learners</i> .....	12
<i>Reflective Aptitude</i> .....	13
<i>Sense of Self</i> .....	13
<i>Relational Ability</i> .....	13
Statement of the Research Problem .....	13
Scope and Limitations .....	14
Summary .....	14



Chapter 2 – Literature Review .....	16
Overview .....	16
Conceptual Framework .....	16
<i>Concept Maps</i> .....	16
<i>Learning Transfer</i> .....	21
<i>The Self, Reflection, and the Self-Reference Effect</i> .....	28
<i>Relational Ability</i> .....	61
Theoretical Framework .....	61
Research Questions and Hypotheses .....	71
Summary .....	72
Chapter 3 – Methodology .....	74
Introduction .....	74
Research Questions and Hypotheses .....	74
Methods .....	77
<i>Study Design</i> .....	77
<i>Study Setting</i> .....	79
<i>Participants and Placement</i> .....	79
<i>Materials</i> .....	81
<i>Measures</i> .....	82
Data Collection .....	84
Data Analysis .....	85
Internal and External Validity .....	86
Summary .....	87

Chapter 4 – Findings .....	88
Demographics & Descriptive Statistics .....	88
Measures & Analysis .....	90
Hypotheses 1, 2a, and 2b .....	95
Hypotheses 3, 4, 5, and 6 .....	96
Conclusion .....	97
Chapter 5 – Summary and Discussion .....	98
Summary .....	98
Purpose & Problem .....	98
Research Questions .....	98
Literature Review .....	99
Methodology .....	100
Findings .....	101
Conclusions .....	101
Conclusion 1 – Concept Maps and Transfer .....	101
Conclusion 2 – Self-reference, Concept Maps, and Transfer .....	102
Conclusion 3 – Self-reference and Age .....	102
Conclusion 4 – Self-reference and The Self .....	104
Conclusion 5 – Self-reference and Relational Ability .....	105
Limitations .....	106
Discussion .....	107
Implications for Practice and Research .....	109
Recommendations for Teaching and Practice .....	109

Recommendations for further research .....	110
Conclusion .....	111
References.....	113
Appendix A: Feedback Script .....	127
Appendix B: GEE Models .....	129
Appendix C: IRB Approval .....	132

## List of Figures

Figure 1. A brief concept map on the learning technique, “retrieval practice.” This concept map addresses the question, “What is retrieval practice?” .....	4
Figure 2. An illustration demonstrating combinatorial entailment. This figure forms relationships between U.S. currency by value. ....	66
Figure 3. Sequence of tasks. ....	79
Figure 4. Simulated power analysis for the study. ....	80
Figure 5. Histogram of Participant Age and Inventory Data. ....	90
Figure 6. Average Transfer Score over Time from Concept Mapping.....	92
Figure 7. Average Transfer Score over Time from Outlines. ....	93
Figure 8. Distribution of Transfer Scores. ....	94
Figure 9. Average Transfer over Time by Participant Age Before and After Treatment (N = 13). .....	103
Figure 10. Average Transfer over Time by Participant Sense of Self Before and After Treatment (N = 13). ....	105

## **List of Tables**

Table 1. Descriptive Statistics of Participants (N = 13). .....	89
Table 2. Descriptive statistics of participant scores across all time points (Obvs = 104). .....	91
Table 3. Prepared feedback addressing participant concept map composition. Adapted from Roessger et al. (2018, p. 16). .....	127
Table 4. Generalized Estimating Equations with Negative Binomial Distribution. ....	129

## **Chapter 1 – Introduction**

### **Overview**

In the spring of 2015, I taught Introduction to Computer Programming. The class was offered at a small, rural community college, and most of the fifteen students were older than me. At the time, I had no formal training in teaching adults, but I was eager to learn on the job. Computer programming is not an easy subject to teach, nor is it easy to learn. Like many analytical skills, it involves a complex set of rules and requires applying different techniques from one scenario to another. Therefore, it was important for my students to learn the fundamental rules and apply them to diverse problems. I considered this act to be a part of problem-solving or critical thinking. However, during my doctoral studies, I learned that I specifically wanted my students to “transfer” their learning. At its most basic, learning transfer is the ability to apply knowledge from one situation to another. Broad (1997) formally defines learning transfer as the “effective and continuing application by learners—to their performance of jobs or other individual, organizational, or community responsibilities—of knowledge and skills gained in learning activities” (p. 2). In the past, learning transfer has been considered an elusive or even fictitious goal (Detterman & Sternberg, 1993). However, recent studies suggest learning transfer is achievable by using the proper techniques (Blume et al., 2010; Burke & Hutchins, 2007). Two techniques that demonstrate transfer are concept mapping and self-reference. In this study, I investigate whether self-reference in concept mapping influences learning transfer.

When learners reference themselves with a cue—or something to be remembered—they are more likely to remember the cue than if they had not referenced themselves. This phenomenon is called “the self-reference effect” (Symons & Johnson, 1997). The self-reference

effect has significant implications for adult learning. It is used in various activities such as reflective narratives (Carson et al., 2016), mental simulation (Allan et al., 2017), and multimedia learning (Moreno & Mayer, 2000). Based on cognitive theories, self-reference draws on autobiographical memory—the mental construct of memory that stores serial events about oneself. Autobiographical memory is distinct from semantic memory—the mental construct of memory that holds related concepts. Although researchers have demonstrated that self-reference is a more powerful mnemonic than semantic approaches (Rogers et al., 1977; Symons & Johnson, 1997), educators often tap solely into semantic memory during classroom activities.

One such semantic activity used in adult learning is concept mapping (Daley, 2010). Concept mapping is an activity in which learners graphically represent concepts and associations. Typically, learners begin with a guiding question. Next, they draw top-level concepts and connect them with lower-level concepts using linking words, or words that relate concepts together, to form propositional statements—like a typical sentence structure. Concept maps take shape as concepts begin to form hierarchical clusters. Finally, learners may associate one collection of concepts across the map to another cluster of concepts, thus creating deep and rich connections (Novak & Gowin, 1984). Researchers suggest concept maps, like self-reference, improve learning outcomes such as recall and transfer (Schroeder et al., 2018).

Unlike self-reference, however, concept mapping, when traditionally taught, is solely a semantic exercise. Few studies have examined self-reference in concept maps. For example, Roessger et al. (2018) found students referenced themselves more in concept maps with repeated practice and feedback. Furthermore, Roessger et al. (2019) found self-reference in concept maps improves learner recall of indirectly related concepts within the learner's map. An indirectly related concept connects to another concept which in turn is directly connected to the self. As

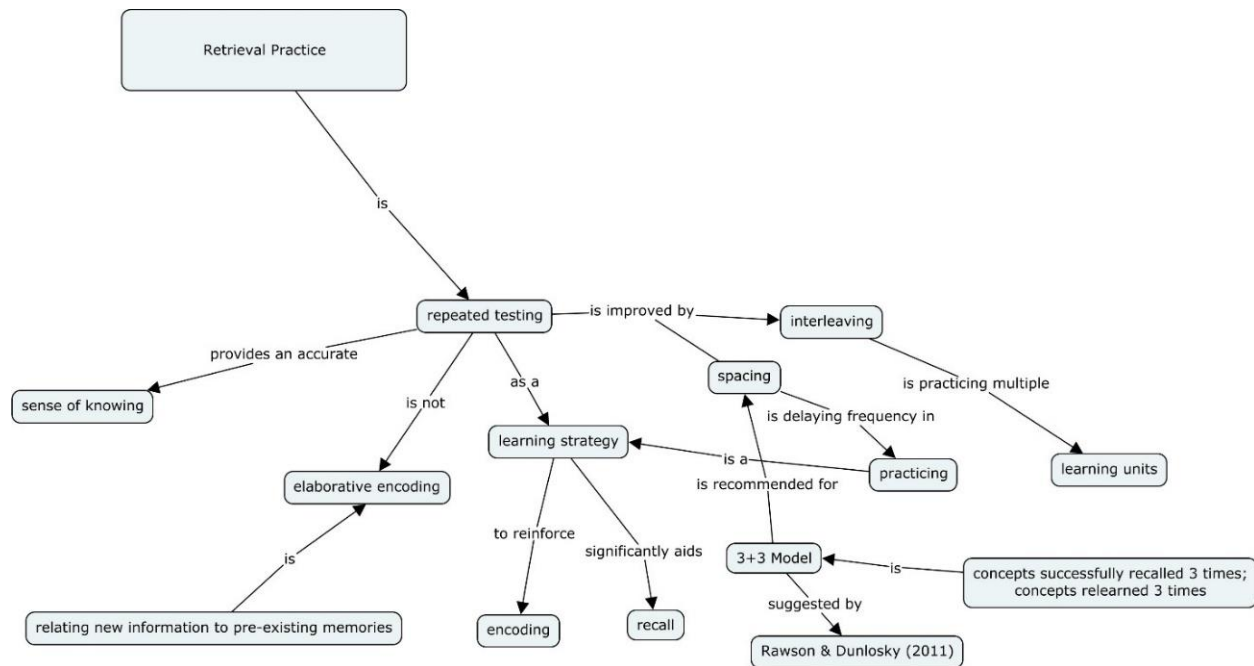
learning transfer is considered a desirable outcome in adult learning (Foley & Kaiser, 2013), I build on the work of these two studies and investigate whether self-reference in concept mapping influences learning transfer. This chapter discusses the study's background, need and purpose, guiding questions, conceptual definitions of variables, and the study's impact on adult learning. I conclude by noting scope and limitations.

## **Background of Study**

### ***Concept Mapping***

According to assimilation theory, meaningful learning occurs when new knowledge anchors onto previously known concepts (Ausubel, 2000). Ausubel (1963) claims that *progressive differentiation* and *integrated reconciliation* are the foundations to progressively build meaningful knowledge within a domain. Learners engage in progressive differentiation when they start with general concepts and hierarchically associate more specific concepts. As they continue to branch into lower-level concepts, they may find concepts in one cluster are associated with another group of concepts. Integrated reconciliation is the process of associating a concept from one cluster to another. To graphically represent this process, Ausubel recommends the use of *advance organizers*. One such advance organizer is the concept map (Novak & Gowin, 1984). Concept maps are “graphical organizers for organizing and representing knowledge” nested within a hierarchical structure and composed of concepts, propositions, and cross-links. See Figure 1 for an example.





*Figure 1.* A brief concept map on the learning technique, “retrieval practice.” This concept map addresses the question, “What is retrieval practice?”

I will discuss concept maps further in Chapter 2, but definitions of each component are warranted here. Within the context of concept mapping, a concept is “a perceived regularity in events or objects, or records of events or objects, designated by a label” (Novak & Cañas, 2008, para. 1). Propositions are associations that link concepts together. Formally defined, they are “statements about some object or event in the universe, either naturally occurring or constructed. Propositions contain two or more concepts connected using linking words or phrases to form a meaningful statement” (Novak & Cañas, 2008, para. 1). Finally, cross-links are “relationships or links between concepts in different segments or domains of the concept map” (Novak & Cañas, 2008, para. 3). Cross-links represent integrated reconciliation in assimilation theory. Overall, components of concept maps represent a rich schema addressing a central theme or question.

After learners construct concept maps, educators have multiple options for assessment. Assessment measures for concept maps are typically either structural, relational, or both. For example, West et al. (2002) found structural scoring to be a good predictor of changes in a learner's knowledge framework. Structural scoring assigns a weighted score for each component in a concept map and tallies the total into a single score. The authors assigned a single concept with two points, a cross-link with ten points, and each hierarchy on the map five points. They calculate a total score by counting and adding each component's weighted score. While structural scores demonstrate the growing connections made by a learner, relational scores assess the extent concepts relate to one another. Roessger et al. (2018) used both structural and relational scores as dependent variables in their study. Relational scores were defined and weighted as follows: a valid relationship with an incorrect propositional label received one point; a valid relationship with a correct propositional label but no relationship to the subject matter received two points; and, valid relationships with correct propositional labels and a connection to the subject matter received three points. Like structural scoring systems, researchers tally these scores and produce a composite relational score. While concept map assessment scores are not the outcome in this study, it is necessary to control the quality of concept maps as it is assumed that concept map quality will vary widely among students.

Concept maps have been studied extensively, demonstrating efficacy as a learning strategy (Schroeder et al., 2018). Researchers have shown positive effects on learning outcomes in a variety of domains, including nursing (Chabeli, 2010; Yue et al., 2017), medical education (Daley & Torre, 2010), computer science (dos Santos et al., 2017), and biology (Schwendimann & Linn, 2015; Wallace & Mintzes, 1990). While many adult educators follow the traditional approach when teaching concept mapping, some encourage learners to reference themselves

within the maps. This approach potentially has a more significant impact on learning outcomes by invoking the self-reference effect.

### ***Self-Reference***

The self-reference effect states that people are more likely to remember information if it relates to themselves. In a seminal study, Rogers et al. (1977) demonstrated the efficacy of the self-reference effect. The researchers conducted two experiments. In the first, they found words that described participants were better recalled than semantic—or meaningfully related—words, words that rhymed, or structurally similar words. In the second, they found words that described participants were recalled better than meaningful words to participants but did not describe one of their traits. The second experiment suggests that participant traits associated with cues are better recalled than cues that are merely meaningful to the participants. Many cognitivist theories supporting the self-reference effect stems from Tulving’s (1972, 1985) distinction between semantic and episodic memory.

Semantic memory stores associated meaningful concepts, such as the association between “sleep” and “bed.” Episodic memory, by contrast, stores temporal events as episodic series. For example, a person remembers that his partner was so tired after a twelve-hour flight to Paris, she immediately went to the hotel room, crashed on the bed, and fell asleep. While the episodic memory contains the semantic association of “bed” and “sleep,” the memory itself is a historical series of events. Within episodic memories are autobiographical memories. Let’s say instead of remembering a partner collapsing into sleep after the long flight to Paris, the subject of the memory was the person. The example would be an autobiographical memory in addition to an episodic memory. Autobiographical memory is thought to be the mechanism for engaging the self-reference effect. But, other studies suggest the self-reference effect is a result of multiple

avenues of retrieving information. Based on a series of experiments, Klein et al. (1989) suggest the self-reference effect occurs both through autobiographical memory and semantic memory, specifically traits relating to the person—that is, how a person sees oneself. This perspective is sometimes called the self-as-prototype (Kuiper, 1981), the epistemological self (Klein, 2012b), or the conceptualized self (D. Barnes-Holmes et al., 2001). Characteristics of the self are likely an essential moderator for self-reference.

In their meta-analysis, Symons and Johnson (1997) conclude the self—as a well-established construct—likely moderates the self-reference effect. This assumption is based on results comparing self-reference to other-reference. In these studies, participants identify target words associated with themselves compared to other familiar people, such as a family member. The meta-analysis reveals a smaller effect size for these studies than those comparing self-reference to semantic cues, implying that a degree of familiarity influences retrieval. Additionally, the authors infer the self-reference effect engages both relational and item-specific processing. Relational processing is a memory construct that encodes information by relating one item to another. On the other hand, item-specific processing encodes information by constructing a mental representation of an item (Hunt & Einstein, 1981). These cognitive mechanisms underlie the significance of self characteristics as strongly reinforced stimuli and the relational magnitude of those characteristics to a sense of self.

Within studies on the self-reference effect, a sense of self and autobiographical memory are both critical components to the effectiveness of relating the self to target words or concepts (Klein, 2012b). It follows that the degree to which a person has developed a sense of self and the ability to self-reflect will moderate the efficacy of self-reference. For example, Dunkel and Lavoie (2005) demonstrate the moderating effects of identity development on the processing of

self-relevant information, suggesting that a learner's sense of self influences the self-reference effect. Furthermore, the adult learning literature is replete with conceptualizations of reflection. In one such conceptualization, Roessger (2017, 2019) frames self-reflection within Dewey's meaning-making criterion, proposing three criteria for reflection as meaning-making processes. He calls his third criterion "transformative meaning making," in which learners relate knowledge to their conceptualized selves. If learners relate knowledge to themselves, the degree to which they make meaning likely hinges on their aptitude for self-reflection. Additionally, adult education theorists suggest age influences learner characteristics such as reflection ability (Knowles et al., 2015). In one experiment, Grant et al. (2002) found that age was a moderating variable on the ability to self-reflect.

Recent research on the self-reference effect focuses more on correlates to neurological physiology, with many studies indicating the medial prefrontal cortex (mPFC)—the part of the brain thought to control episodic memories—is the biological mechanism that regulates the self-reference effect (Macrae et al., 2004; Philippi et al., 2012; Yaoi et al., 2015). Most studies examining outcomes of the self-reference effect focus on recall or recognition. However, an important learning outcome for adult educators, and central to this study, is learning transfer.

### ***Learning transfer***

Learning transfer is an often sought-after outcome, and sometimes assumed byproduct, of adult learning (Merriam & Leahy, 2005). Learning transfer is the ability to apply learning in one situation to another. Researchers debate if learning transfer is an achievable outcome, particularly whether learning can be generalized or used outside of its original context (Baldwin & Ford, 1988). In education and training, learning transfer is an aspirational goal for learners. In many cases, the utility of learning is stifled if learning does not generalize beyond the original activity.

Because of this, instructional strategies that facilitate transfer are increasingly important, particularly when learners need to continually upgrade or learn new skills. Research on both concept mapping and the self-reference effect demonstrate notable transfer outcomes (Moreno & Mayer, 2000; Nesbit & Adesope, 2006).

However, no study has investigated whether combining self-reference and concept mapping influences learning transfer. Roessger et al. (2018) found repeated practice and feedback encouraged self-reference in concept maps, and Roessger et al. (2019) found self-reference in concept maps influenced recall. Additionally, Roessger et al. (2018) also examined the effectiveness of teaching concept maps from relational frame theory (RFT), a pragmatic and behavior-analytic approach to verbal and higher-order cognition. While structural scores of concept maps were similar between the RFT and control groups, the RFT group achieved higher relational scores. Relational reasoning links to higher-order learning and cognitive ability (Dumas et al., 2013; Hofstadter, 2001), with some suggesting it is the underlying mechanism for learning transfer (Haskell, 2001). As relational reasoning is essential to relating concepts, and theory suggests it may be an underlying mechanism of learning transfer, then relational ability must be considered a potential moderating variable.

The results of this study have significant implications for both theory and practice. If self-reference in concept mapping positively influences learning transfer, this activity would be helpful in situations where learning transfer is an important outcome. Organizational trainers could use self-referent concept mapping as a workshop activity to help employees transfer learning to the job. Career and technical education faculty may find it helpful to use self-referent concept mapping when teaching skills-based material. I extend the Roessger et al. (2019) study by examining whether self-reference in concept maps also influences learning transfer. I use a

segmented repeated-measures design as the method of inquiry, controlling for age and concept map scores. Based on the literature discussed in Chapter 2, I also account for possible moderators such as sense of self, reflective aptitude, and relational ability.

### **Need and Purpose**

In conducting this study, I address calls by the adult learning community to actively encourage and study learning transfer (Daley, 2001; Foley & Kaiser, 2013; Merriam & Leahy, 2005). I also follow the recommendations of Roessger et al. (2018) to examine potential learning outcomes of self-reference in concept mapping. Whereas Roessger et al. (2019) examined the influence of self-reference in concept maps on recall, I explore learning transfer as the outcome. Additionally, the authors' study was a cross-sectional experiment in a controlled environment. I expand this examination in an authentic setting, using repeated measures to account for growth. This study's findings will be beneficial for adult educators who use concept mapping as an instructional activity and adult education researchers interested in concept mapping's learning outcomes. Finally, this study will contribute to relational frame theory by further extending its application in adult learning. Those using relational frame theory as a theoretical framework typically focus on psychology research. However, some advocate its use in adult learning and instructional design (Fox, 2006; Parker & Roessger, 2020; Roessger, 2017, 2019; Roessger et al., 2018). Finally, most practical studies on learning transfer are within organizational settings (Merriam & Leahy, 2005). I aim to further the literature on learning transfer within the classroom.

The purpose of this study, then, is to investigate whether self-reference in concept mapping influences learning transfer over time in an authentic classroom setting. I accomplish this with a segmented repeated-measures design, using self-reference instruction as an

intervention during the study. Participants in a graduate-level adult education class will create eight concept maps throughout a semester term. My outcome variable is learning transfer, operationalized by a score from a writing prompt assigned one week after each concept map. My primary variable of interest is self-reference instruction intervention, which is introduced halfway through the study. I consider age, reflective aptitude, sense of self, and relational ability as moderating variables. I discuss these further in Chapter 2.

## **Definitions**

I use standard definitions to refer to variables and unique terminology. However, given the nature of the literature, some terms may be interchangeable, such as “learning transfer” and “transfer.” I will note this in the literature. Otherwise, I use the variables consistently as defined. Definitions used throughout this study are:

### ***The self-reference effect***

The self-reference effect is “the mnemonic superiority from relating material to the self” (Symons & Johnson, 1997, p. 371).

### ***Transfer***

Transfer is defined conceptually as “effective and continuing application by learners—to their performance of jobs or other individual, organizational, or community responsibilities—of knowledge and skills gained in learning activities” (Broad, 1997, p. 2).

### ***Concept***

A concept is “a perceived regularity in events or objects, or records of events or objects, designated by a label” (Novak & Cañas, 2008, para. 1).



### ***Concept Map***

Concept maps are “graphical tools for organizing and representing knowledge” (Novak & Cañas, 2008, para. 1).

### ***Proposition***

Propositions are “statements about some object or event in the universe, either naturally occurring or constructed. Propositions contain two or more concepts connected using linking words or phrases to form a meaningful statement” (Novak & Cañas, 2008, para. 1). In an RFT-based concept mapping exercise, propositions use linking words that relate one concept to another through equivocation, distinction, hierarchy, perspective-taking, or another relationship (Roessger et al., 2018).

### ***Cross-link***

Cross-links are “relationships or links between concepts in different segments or domains of the concept map” (Novak & Cañas, 2008, para. 3).

### ***Concept Map Scores***

Concept map scores are control variables in this study. Many scoring models are used in the literature (Anohina & Grundspenkis, 2009), and most are considered valid (Jablokow et al., 2013). Scoring is often separated into three categories: a) Structural—scoring based on the components of a concept map, b) Relational—scoring based on the validity of the relationships to the content, and c) Mixed—a combination of structural and relational scores.

### ***Adult Learners***

For this study, an adult learner is defined as “a diverse group—typically age 25 and older—with a wide range of educational and cultural backgrounds, adult responsibilities and job

experiences. They typically do not follow the traditional pattern of enrolling in postsecondary education immediately after high school” (SREB, 2020, para. 1).

### ***Reflective Aptitude***

Reflective aptitude is the degree to which a person can engage in metacognitive thinking that allows understanding of their emotions and behavior (Grant, 2001).

### ***Sense of Self***

Flury and Ickes (2007) define sense of self as ranging on a continuum from individuals possessing a weak sense of self to a strong sense of self. They state the defining characteristics of an individual with a weak sense of self are “feeling as if they do not know who they are, what they think, what their own opinions are, or what religion they should adopt” (p. 281).

### ***Relational Ability***

Relational ability is a person’s ability to form relationships between concepts. In relational frame theory, it is considered a skill and measure of cognitive ability (Cassidy et al., 2011, 2016).

## **Statement of the Research Problem**

In examining these relationships, I ask the following questions:

- After repeated practice and feedback, does concept mapping affect the transfer of learning?
- After repeated practice and feedback, does self-reference in concept maps affect transfer of learning?
- Is there an interaction between self-reference in concept maps and a learner’s age on the growth of learning transfer?

- Is there an interaction between self-reference in concept maps and a learner's reflective aptitude on the growth of learning transfer?
- Is there an interaction effect between self-reference in concept maps and sense of self on the growth of learning transfer?
- Is there an interaction effect between self-reference in concept maps and a learner's relational ability on the growth of learning transfer?

### **Scope and Limitations**

The scope of this study examines adult learners in a graduate adult and lifelong learning program at a large, public university in the southern United States. The study focuses on a limited number of adult learners within the specific context of a United States university in Arkansas, which may affect the generalizability of the study. While I have extracted potential moderators and controls, there are possible, unknown confounding variables that may weaken the study's conclusions. As a functional contextualist, I am aware that I am also an active part of this study, and my relational repertoire—my historical behavior that forms my sense of self—influences this study.

### **Summary**

This chapter detailed the background, needs, and purpose of this study, my research questions, definitions, and scope and limitations. I discussed the efficacy of the self-reference effect and concept mapping in contributing to learning outcomes and how there is a theoretical and practical need to determine whether integrating both techniques influence learning transfer. I briefly described the purpose of the study and how I will conduct it. I also discussed how aspects of the self, such as sense of self and reflective aptitude, and relational ability are potential

moderators. Chapter 2 will discuss the literature and how the theoretical framework—relational frame theory—drives the study.

## **Chapter 2 – Literature Review**

### **Overview**

Education researchers have prolifically studied the effects of concept mapping on learning outcomes (Schroeder et al., 2018). However, few have examined concept mapping within relational frame theory or the influence of self-reference in concept mapping on learning. The literature suggests concept mapping and self-reference influence transfer (Moreno & Mayer, 2000; Nesbit & Adesope, 2006). But, whether self-reference in concept mapping affects transfer is inconclusive. This gap in the literature provides an opportunity to explore further the learning benefits provided by concept mapping. I found several potential moderating variables by looking at prior literature on the self-reference effect, transfer, and concept mapping. For example, self-reference is closely tied to a person's sense of self (Dunkel & Lavoie, 2005; Klein & Nichols, 2012) and their ability to observe oneself (Groninger & Groninger, 1988). And, a person's innate or learned ability to relate concepts may impact their ability to construct concept maps and transfer knowledge to novel applications (Colbert et al., 2017; Dumas et al., 2013; Haskell, 2001).

This chapter examines the historical, conceptual, and empirical literature of concept maps, transfer, and the self. Additionally, I explore relational ability and its potential influence on concept mapping and learning transfer. I then discuss and summarize the literature and analyze how these variables relate to relational frame theory.

### **Conceptual Framework**

#### ***Concept Maps***

Concept maps are defined as “graphical tools for organizing and representing knowledge” (Novak & Cañas, 2008, para. 1). Novak developed concept maps in the early 1970s to

operationalize Ausubel's assimilation theory (Novak & Cañas, 2006, 2008). Assimilation theory is a cognitive-constructivist approach to understanding knowledge acquisition in which verbal and expository learning is meaningful if it anchors and assimilates with a learner's prior knowledge. The primary cognitive processes that underlie assimilation theory are subsumption, progressive differentiation, and integrative reconciliation. Ausubel describes subsumption as new concepts learned, subsumed, and integrated with known concepts, which is necessary for meaningful learning. Progressive differentiation assumes a hierarchical cognitive structure with generalized concepts at the top of the hierarchy and conceptual specificity branching from top to bottom. As branches begin to grow in this hierarchical cognitive structure, integrative reconciliation is likely. Integrative reconciliation is the act of nonlinearly associating a concept or concept cluster to another concept or concept cluster. They are typically associated with "ah-ha!" moments where a learner discovers a novel relationship. To facilitate assimilation theory, advance organizers graphically represent this knowledge structure (Ausubel, 1963, 2000).

A type of advance organizer is the concept map. Novak and Cañas (2008) define the structural composition of a concept map:

- Concepts – “a perceived regularity in events or objects, or records of events or objects, designated by a label” (para. 1)
- Propositions – “statements about some object or event in the universe, either naturally occurring or constructed. Propositions contain two or more concepts connected using linking words or phrases to form a meaningful statement” (para. 1)
- Cross-links – “relationships or links between concepts in different segments or domains of the concept map” (para. 3)

- Hierarchical positioning – “concepts are represented in a hierarchical fashion with the most inclusive, most general concepts at the top of the map and the more specific, less general concepts arranged hierarchically below” (para. 2)

These components align with the schema of assimilation theory. Propositions represent the subsumption of one concept under another. Hierarchical positioning within a concept map facilitates progressive differentiation, and cross-links represent integrative reconciliation. While my research is concerned with concept maps as a learning tool, it is worth mentioning that Novak and Gowin (1984) envision assimilation theory to be an encompassing theory of education. For them, concept maps and Vee diagrams—another advance organizer—are used throughout all aspects of education, from learning and assessment to research. As an assessment tool, researchers have focused significant effort to find the best approaches for scoring concept maps (Anohina & Grundspenkis, 2009). Scoring involves evaluating concept maps by comparing them to expertly created concept maps, examining their structural and relational composition, analyzing their qualitative characteristics, and other techniques. While Novak and Gowin (1984) suggest a method for scoring concept maps, many have contributed different methods (Jablokow et al., 2013).

Recent reviews provide a tremendous body of evidence suggesting the efficacy of concept maps as a learning tool. Schroeder et al. (2018) conducted a meta-analysis that examines the effectiveness of concept mapping on learning outcomes compared to other instructional tools. For inclusion in the analysis, studies must have “(a) contrasted the effects of map study, construction, or manipulation with the effects of other learning activities; (b) measured cognitive or motivational outcomes such as recall, problem-solving transfer, learning skills, interest, and attitude; (c) reported sufficient data to allow an estimate of standardized mean difference effect

size; (d) assigned participants to groups prior to differing treatments; (e) randomly assigned participants to groups, or used a pretest or other prior variable correlated with outcome to control for preexisting differences among groups” (p. 436). The meta-analysis used Hedge’s  $g$  statistic to estimate effect sizes. Overall, concept maps in this study had a moderate effect size,  $g = .58$ ,  $p < .001$ ,  $k = 142$   $n = 11,814$ , compared to several other learning tasks, such as note-taking, listening to lectures, creating outlines, and studying texts.

Additionally, there have been several systematic literature reviews, particularly within specific disciplines and domains. Recent reviews include examining concept maps in nursing, medicine, human resource development, and computer science (Chabeli, 2010; Daley et al., 2010, 2016; Daley & Torre, 2010; dos Santos et al., 2017). These reviews build upon previous literature reviews, demonstrating the history of concept mapping as an effective learning strategy. Kinchin (2014), however, argues that there are methodological issues within some of the previous literature reviews. Notably, he argues that the results of the literature reviews are mixed depending on how concept maps are taught. For instance, he concludes from the literature that a broad “concept maps are effective” claim is misleading. Instead, he suggests concept map activities are more effective when used within specific pedagogical contexts and environments. For example, Kinchin mentions the importance of practice and feedback rather than one-off concept map construction.

Supporting Kinchin’s claim, Morse and Jutras (2008), in a longitudinal study, concluded that feedback likely contributed to greater success in concept map outcomes among university biology students. However, feedback was not an isolated variable in the study. Lachner, Backfisch, and Nückles (2018) studied concept maps specifically as a feedback tool rather than a learning strategy. They asked participants to create and revise conceptually cohesive text based



on concept map-based feedback. Three groups were randomly assigned. One group received accurate feedback, another inaccurate feedback, and the control group received no feedback. The feedback groups received feedback through CohViz, a computer generated feedback program (Lachner et al., 2017). The results indicated the group receiving accurate feedback performed revisions better than the inaccurate and no feedback groups. Using contrast analysis, the accurate feedback group performed significantly better than the no feedback group,  $F(1, 55) = 6.39, p = .01, \eta^2 = .10$ . In addition, the accurate feedback group performed significantly better than the inaccurate feedback group,  $F(1, 55) = 4.26, p = .02, \eta^2 = .07$ .

Roessger et al. (2018) further researched the impact of practice and feedback on concept mapping within an authentic setting. Additionally, they investigated teaching concept maps within a relational frame theory perspective compared to the conventional constructivist perspective. In a quasi-experimental, repeated measures study, both RFT and constructivist groups received standard feedback. Using a generalized estimating equation (GEE) model, they found a significant main effect in the third measure suggesting feedback improved relational scores for those in the treatment group,  $\chi^2(1) = 5.67, p = .02, 95\% \text{ CI } [1.25, 12.91]$ . Additionally, feedback increased structural scores in both groups over time,  $\chi^2(1) = 11.42, p = .001, 95\% \text{ CI } [6.09, 22.91]$ . As relational scores conceptually link to relational reasoning (Dumas et al., 2013), this study has implications for teaching concept mapping through a relational frame lens. While the researchers did not assess the influence of the self-reference effect on concept maps, they did find the number of self-referent concepts increased with feedback.

Only two studies examine the influence of self-reference in concept maps on learning outcomes, and they provide mixed results. In an experimental study, Roessger et al. (2021) analyzed concept maps at the structural level and examined whether specific concept map

components contributed to concept recall. But, they found the number of self-referent concepts did not significantly contribute to participant's ability to recall those concepts. Another experimental study by Roessger, Greenleaf, et al. (2019) found participants who referenced themselves in concept maps recalled more concepts than those who didn't self-reference in concept maps. Oddly, they found the concepts recalled were indirectly related to the words associated with self-reference. That is, concepts related to other concepts related to one's self were more likely to be recalled.

Concept maps have a rich empirical body of research as an effective learning strategy. However, their effectiveness depends on instruction. Researchers suggest practice and feedback are critical components, but few have examined the influence of self-reference in concept maps on learning outcomes. The little research that currently exists has produced mixed results and only studied recall. I hope to expand this literature using a similar approach to Roessger et al. (2018), exploring concept mapping in an authentic environment with practice and feedback.

### ***Learning Transfer***

Broad (1997) defines learning transfer, sometimes called “transfer of learning,” “transfer of skills,” or simply “transfer,” as “effective and continuing application by learners—to their performance of jobs or other individual, organizational, or community responsibilities—of knowledge and skills gained in learning activities” (p. 2). While many educators now consider learning transfer indispensable to successful learning, psychology researchers have studied transfer for over a century. Thorndike and Woodworth (1901) conducted one of the earliest experimental studies on learning transfer, gauging the ability of learners to perform a similar task to one previously known. In the early twentieth century, studies of learning transfer focused on various types of learning, including motor skills, muscle memory, reasoning, and skills training

(Woodrow, 1927; Barlow, 1937; Gagné et al., 1948). Early literature mainly focused on the transfer of training and workplace skills (Baldwin & Ford, 1988), with debate on whether transfer could occur (Detterman & Sternberg, 1993).

Learning transfer persists as an aspirational goal within adult and continuing education. In their review of learning transfer, Merriam and Leahy (2005) focused on its application within adult learning, suggesting that Knowles's andragogical principles—specifically adult participation in constructing their knowledge—contribute to transfer effectiveness. Daley (2001) studied the continuing education of professional workers and concluded that learning transfer is not a generalized cognitive skill but is contextual and based on subject knowledge. Foley and Kaiser (2013) argue that learning transfer should not be understood as *facilitating* adult learning. Instead, learning transfer is *integral* to adult learning. Adults transfer skills in work and the classroom and informal settings such as gardening, home repairs, and hobbies. Furthermore, Foley and Kaiser argue for various methods to aid transfer for adult learners, including concept mapping. Roumell (2019) suggests educators can adopt novel approaches to enhance transfer for adults. She proposes “mindful transfer” as a collection of scaffolding strategies to develop transfer skills in learners. Her conceptualization of mindful transfer encompasses three processes: examining personal commitments, crafting stories and relevant cases, and taking ownership of newly acquired competencies among peers. While she does not use RFT as a framework, Roumell's conceptualization of teaching transfer skills parallels the value, commitment, and mindfulness strategies advocated in RFT-derived practices (Hayes, Strosahl, et al., 2012).

In addition to the adult education literature, learning transfer has been studied extensively in psychology and human resource development. Arguments over when, how, and to what extent

transfer occurs are prominent themes. Singley and Anderson (1989) note common dichotomies within learning transfer research in reviewing the historical literature. A dominant issue is whether learning transfer is specific in scope or if it can be generalized across disciplines. Early behavioral psychologists studied learning transfer as a phenomenon that was specific to certain tasks. For example, if a carpenter learned how to install supporting brackets in furniture, could they transfer that skill to install similar supporting brackets in frame structures? Liberal educators and developmental psychologists, on the other hand, viewed learning transfer as broad and cross-disciplinary. If students learned abstract mathematics, they should know how to apply those problem-solving and reasoning skills to areas as diverse as mechanical troubleshooting and logical reasoning. Another common distinction in learning transfer is meaningful versus rote learning. Here, the argument is that simple task learning does not transfer as much as structural learning. Singley and Anderson provide an example of an experiment with students playing darts. Researchers submerged the dartboard under water in the first round, whereas the dartboard was submerged partially under water in the second round. Half the group received instruction on the physics of refraction, while the other half received no instruction. Both groups performed the same during the first round. However, the group that received instruction on refraction performed better during the second round than the group that did not receive instruction.

Additionally, researchers made the distinction between lateral and vertical transfer.

Singley and Anderson (1989) differentiate between the two:

Lateral transfer was defined as the kind of transfer that spreads over a broad set of situations at roughly the same level of complexity. For example, transfer between different programming languages, between different puzzle problems, like tower-of-Hanoi and missionaries-and-cannibals, or between speaking English and French all qualify as instances of lateral transfer. Vertical transfer, however, concerns transfer between lower-level and higher-level skills that exist in a part-whole, prerequisite relationship to one another (p. 16).

Vertical transfer is conceptualized as a hierarchy, with higher-order prerequisite skills at the top and dependent and interconnected skills flowing down—similar to the structure of a concept map. More recent research has focused on learning transfer in the context of analogical reasoning, in which learners apply similar problem-solving strategies from one issue to another. However, according to Singley and Anderson, learners often fail to transfer problem-solving approaches because they do not recognize the similarities in the problem.

Explaining transfer processes, Haskell (2001) suggests following a set of learning principles. These principles can be categorized as a) obtaining prior knowledge in areas intended to be transferred, b) learning the transfer techniques, c) practicing transferable skills, and d) allowing time to reflect on learning. He notes the paradox of transfer—that transfer is often sought as a foundational learning outcome but is rarely achieved. Haskell’s definition of transfer, however, transcends a mere learning outcome. He describes transfer as “the basis of mental abstraction, analogical relations, classification, generalization, generic thinking, induction, invariance, isomorphic relations, logical inference, metaphor, and constructing mental models” (p. 26). For Haskell, transfer is the foundation of higher-order cognition. Furthermore, he concludes that there are six levels of transfer: nonspecific, application, context, near, far, and displacement transfer. The first level, nonspecific transfer, is everyday learning, arbitrarily relating knowledge to some connection in the past. Application transfer is learning and applying a specific task. Haskell provides an example of learning about a word processor and then actually using one. Context transfer applies knowledge to a slightly different situation in a different context, such as the carpenter installing supporting brackets in framing structures after learning how to install them in furniture. Near and far transfer are examples of context transfer. Near transfer applies learning to a very similar situation, whereas far transfer applies learning to a

much different problem. Haskell notes that analogical reasoning is an example of far transfer. As one might expect, research suggests near transfer is easier to achieve than far transfer (Blume et al., 2010). Additionally, educators and researchers often view near and far transfer as a continuum. Haskell's final level of transfer is displacement. Displacement, or creative, transfer is transferring learning in novel ways. Learners discover or create a new concept within the interaction of new and old learning. Haskell's principles and levels summarize much of how researchers have historically distinguished types of learning transfer.

In their review of the literature, Baldwin and Ford (1988) found a “transfer problem”—that is, transfer appears to be illusive as a learning outcome. However, recent reviews of the literature are more optimistic. Extending Ford & Weissbein's (1997) review, Burke and Hutchins (2007) examined the influence of learner characteristics, intervention design and delivery, and the environment on learning transfer. For learners, cognitive ability, self-efficacy, motivation before initial learning (particularly intrinsic motivation), openness to experience, perceived utility of the instruction, and high career orientation all had moderate to strong effects on learning transfer. They also found a negative relationship between transfer and negative dispositions such as anxiety. For instructional interventions, they found moderate to strong support for instruction that established learning goals, ensured relevant content, used continued practice and feedback, modeled behavior, and provided error-based examples. The authors note that research on the influence of the work environment has significantly expanded since Baldwin and Ford's (1988) review. They found moderate to strong relationships between learning transfer and supervisory support, peer support, transfer climate—a climate where learners are encouraged to use new skills, and the opportunity to perform learned skills.

Blume et al.'s (2010) meta-analysis on learning transfer quantified the effects in the categories outlined by Burke and Hutchins (2007). The authors note the difficulties in operationalizing transfer, citing definitional inconsistency. Therefore, they categorized studies of learning transfer within two dimensions: generalization and maintenance. Generalization is the extent to which learning is applied in different contexts, while maintenance is the persistence of changes that result from a learning experience. Using this framework, the authors searched studies from 1988-2008 but separated studies that contained "same source" or "same-measurement-context" (SS/SMC) methods. For example, a study was labeled as SS/SMC if it reported self-measures of input (i.e., motivation) and output. They indicate these studies highly inflate transfer relationships, but their meta-analysis mostly aligns with the findings from Burke and Hutchins (2007). Excluding SM/SMC studies, the researchers found a learner's cognitive ability ( $\bar{r} = .37$ ), conscientiousness ( $\bar{r} = .28$ ), and voluntary participation ( $\bar{r} = .34$ ) have moderate relationships with learning transfer outcomes. Within environmental contexts, they found that transfer climate ( $\bar{r} = .27$ ) and support ( $\bar{r} = .21$ ), particularly supervisor support ( $\bar{r} = .31$ ), had the highest correlations with transfer outcomes. Reporting on a small number of studies ( $K=3$ ), they found a moderate relationship between optimistic preview—demonstrating the value and relevance of the instructional activity—and transfer outcomes ( $\bar{r} = .20$ ). Other instructional interventions showed small effect sizes. However, the authors advise caution on these results due to the limited number of studies. Additionally, the meta-analysis showed moderating effects between lab studies and field studies, with field studies generally having a larger effect. Operating within the maintenance dimension, the authors found moderating effects between the time transfer was measured. Unsurprisingly, studies with a considerable time lag demonstrated a more negligible effect on transfer outcomes.

Tonhäuser and Bükér (2016) examined empirical literature explicitly focusing on learning transfer in continuing and professional education between 1990 and 2015. Following the frameworks of Baldwin and Ford (1988), Ford and Weissbein (1997), and Burke and Hutchins (2007), they examined moderating variables within learner characteristics, organizational environment, and content and design of the original training. The authors found similar relationships mentioned in previous reviews. At the organizational level, social support—support and feedback by supervisors and peers—and a climate that encouraged practicing learned skills in different contexts had strong evidence for transfer outcomes. For individual characteristics, they found research supported motivation, self-efficacy, and various personality traits, such as conscientiousness and openness to experience, as positive transfer outcomes. Negative affective traits—neuroticism, anxiety, and emotional instability—adversely affected transfer outcomes. For training interventions, the relevance of the activity, setting learning goals, behavioral modeling, and feedback led to positive learning transfer outcomes.

In the past, educators and researchers viewed learning transfer as the holy grail, a mythological outcome that was rarely, if ever, achieved by instructional intervention. Recent research, however, suggests learning transfer is achievable but dependent on learner characteristics, initial task design, and environmental factors. Based on the literature, if self-reference in concept mapping is to influence learning transfer, learners must place value and relevance on the activity, learn from modeled behavior, and receive appropriate feedback. The design of this study provides learners with proper scaffolding, incorporating modeling and feedback. Additionally, as discussed in the next section, I argue self-reference with concept maps is likely to influence transfer due to an added layer of value and relevance.



### ***The Self, Reflection, and the Self-Reference Effect***

The concept of “self” is complex and widely debated. While studied in philosophy for millennia, William James brought the self into the fold of psychology in the late nineteenth century. James (1890/1918) argues that there are four distinct “constituents” of self within two classes. In one class, the self is composed of “the material Self,” “the social Self,” and “the spiritual Self.” The material self is associated with the objects in the physical world, such as clothes and family. Social recognition, such as a person’s honor, dignity, and integrity, partially forms a person’s sense of self. In contrast, the spiritual self defines a person’s thoughts, emotions, and morals—the world of intangible things. While these selves are distinct, they often interact with one another and sometimes engage in rivalry. For example, a person may seek influence (the social self) to the detriment of morality (the spiritual self). These three selves encompass self-perception; however, James also suggests a second class of self, “the Ego.” The Ego forms a person’s identity and unites all selves. However, it is not a static entity; there is no “ghost in the machine” or a homunculus taking the reins of the mind. Rather, the Ego that unifies the constituents of the self is connected thoughts. It is the collection of all memories; it is the stream of consciousness—past and present. Taking this perspective, James provides a naturalistic approach to the self, one that is open to empirical study. His distinction between the former “me-self” and the latter “I-self” has significantly influenced psychological studies of self and identity into the present (Prebble, 2014).

While James offers a pragmatic perspective, Kegan (1982) takes a constructivist-developmental approach to the self, in which developmental phases influence how a person constructs meaning. The core of his ideas constitutes an evolutionary approach to self and identity. He cites two conceptual strands of meaning-making: a logical, systematic theory of

development and an existential process of generating context when faced with something unfamiliar. His approach seeks to combine the two into what he calls “the evolving self.” The evolving self involves a process called differentiation, defined as “creating out of the former subject a new object to be taken by the new subjectivity” (p. 31). Meaning-making, therefore, is a series of historical transformations in which people relate new knowledge about the world by differentiation. As a self-described neo-Piagetian, Kegan’s approach to the self takes the form of developmental stages. These developmental stages shift a person’s self-perspective from “subject”—the person and environment are the same—to “object,” in which a person perceives themselves as an agent *within* the environment.

Kegan refers to the first stage of self as “the impulsive balance.” This stage reflects infancy to early childhood, in which adaptability is the primary action of making meaning. In this stage, a child views objects as extensions of themselves. Therefore, if a child’s perception changes, the object changes. As an example, Kegan cites Piaget’s experiment with four-year-old children. In the experiment, Piaget placed two identical containers in front of the children. He then poured equal amounts of water into each container and asked the children which container contained more. All the children confirmed they were the same. However, when he poured the same volume of water into containers of different shapes—one tall and thin, the other short and wide—the children mistakenly claimed the taller, narrower container had more water. Interestingly, when Piaget poured the water back into the original containers, the children said they *now* contained the same amount, implying the quantity of water changes depending on the shapes of the containers.

The second stage is “the imperial balance.” During this stage, children begin to develop a self-concept. The child now has a sense of agency and is intentional about doing something with

new experiences. Likewise, the child understands the other, and they are aware of the consequences of their actions. They may not perceive another's feelings, but they know how their actions will affect the other's attitude toward themselves.

While the first and second stages are typically associated with children, Kegan's third, fourth, and fifth stages are focused more on adolescents and adults. He calls the third stage "the interpersonal balance." This stage marks a shared sense of self with others. In this stage, a person can recognize the needs of others but struggles with self-coherence and forming an individualized identity. They cannot know themselves apart from an interpersonal context. The identities of others—the characteristics and actions of a group—shape a person's sense of self. Consequentially, people in this stage have trouble expressing their own thoughts and emotions.

The fourth stage, which Kegan considers the most prevalent in adults, is "the institutional balance." This stage marks the formation of identity outside of the interpersonal context. In this stage, a person can regulate emotions and transition those emotions from "subject" to "object." A person sees themselves as part of a system and claims ownership rather than participating in a shared context. However, organizational characteristics constrain the self, which makes it inherently ideological. It is bound by institutions, such as culture, religion, and social organizations.

The fifth and final stage of self is "the interindividual balance." This stage has the characteristics of "the institutional balance," except those in this stage cast off institutions as identity. They can see and reflect on their ideologies. It is the complete shift from "subject" to "object." This stage is comparable to Maslow's self-actualization, and Kegan sees it as a rarity. Kegan's meaning-making and the self takes an evolutionary and contextual stance on self-development. In Kegan's later works, he reframes the developmental stages—mainly the latter

three—as epistemologies. These reflect the influence of Mezirow’s transformative learning theory. For example, “the interpersonal balance” becomes “the socialized mind,” “the institutional balance” becomes “the self-authored mind,” and “the interindividual balance” becomes “the self-transforming mind.” A person with “the self-authored mind” has independent identity formation, self-regulation, and autonomy. A person capable of reaching the fifth epistemology, “the self-transforming mind,” transcends ideology and engages in dialectical thinking (Kegan, 2009).

Contrasting with Kegan’s perspective is relational frame theory (RFT). RFT, a theory of verbal learning and cognition, will be further discussed in the theoretical framework, but significant literature exists on the self from an RFT perspective. In RFT, the self develops when people relate perspective-taking concepts—relationships between “I” and “You” or “Here” and “There”—to other ideas within a person’s learned history. In the RFT literature, these relationships are called “deictic” relationships. Deictic means relationships must be taught through demonstration and examples. They are distinguished from other relationships, such as coordination and comparative, where relationships can be derived instead of taught. For example, a comparative relationship would be “Harry is older than Tom,” where it’s possible to derive that “Tom is younger than Harry.” Yet, in a deictic relationship, we could say, “I was here yesterday,” but we cannot derive where “I” am today. Deictic relationships form a person’s perception of the world, requiring a sufficiently developed relational repertoire to anchor those relationships. Therefore, theorists propose that deictic relationships develop after other kinds of relationships (Y. Barnes-Holmes et al., 2013). Perspective-taking properties are learned by abstractly talking about one’s perspective in relation to others’ perspectives. Deictic frames are spatially and temporally limited to “I-YOU,” “HERE-THERE,” and “NOW-THEN”

relationships. For example, a simple deictic relation is “I am at the library, and Sara is at the coffeeshop.” This relationship uses both “I-YOU” and “HERE-THERE” relationships: (I) am at the library (here), and Sara (you) is at the coffeeshop (there) (D. Barnes-Holmes et al., 2001).

As other relationships anchor to deictic relationships, a person’s sense of self emerges. RFT posits three distinct selves: the conceptualized self, the knowing self, and the transcendent self. We generally think of the conceptualized self as identity, also known as the “self-as-content”—traits that people assign to themselves based on their learned history. For example, “I am a good person.” A conceptualized self is vital for human development, but it can also have negative consequences. A person might force a THERE and THEN frame into a rigid HERE and NOW frame. They may attribute a historical event as a characteristic of themselves. For example, in high school, Richard was a mediocre student. His peers and teachers reinforced this idea through their behavior. Into adulthood, Richard infused his past behavior with his current self—“In high school (there and then), I wasn’t good in school; therefore, I (here and now) am not good at school.” Notably, the truth of whether Richard was good or bad at school is irrelevant. Regardless, he developed this relationship (bad) between his environment (school) and his conceptual self (I). According to RFT, this can lead to a distorted sense of self. If a historical reason defines a personal characteristic, a person finds themselves in a behavioral trap. The antecedent cannot change unless the past changes. Since the past cannot logically change, the person must change. However, if a person changes, then that person was wrong about the cause of the personal characteristic, which can be challenging to confront (D. Barnes-Holmes et al., 2001). Therefore, a person can develop a healthier sense of self by reflecting and separating events from their identity, recognizing the self-as-process.

The “self-as-process,” also called the knowing self, is when a person can understand and name their emotions and those of others. This self is similar to Kegan’s “the institutional balance” stage. It is the tipping point where the “subject” begins to view themselves as “object.” Here, we should note that RFT describes thoughts as private behavior or as a consequence of environmental stimuli rather than a spontaneous emanation from a cognitive black box. As such, RFT argues that thoughts are functionally contextual; they are influenced by prior relationships a person has formed within their contextual past. Consequently, thoughts can be transformed by relating them to other events in a different context. For example, a common mindfulness meditation technique involves a person envisioning a parade marching with their thoughts on placards, objectifying their thoughts and separating them from one’s self. A person transitions their thoughts from a HERE and NOW perspective to THERE and NOW, providing a level of self-perception (D. Barnes-Holmes et al., 2001).

The observable self, sometimes called the transcendent self or the “self-as-context,” is most closely aligned with spirituality and transcendence (Hayes & Gregg, 2000). The observable self sees consciousness as stable and immutable, without the historical and environmental baggage of the conceptual self. In this sense, the observable self is related to Kegan’s “the interindividual balance.” The final shift from “subject” to “object” regulates the conceptual self and the knowing self as a unification of self-perception. All three selves are involved in higher-order cognitive processes such as problem-solving and critical thinking. The conceptual self determines how a person's traits are considered in a decision, while the knowing self provides abstract decision-making methods. However, the observable self moderates the other two selves, ensuring neither one dominates the decision-making process (D. Barnes-Holmes et al., 2001).

In adult learning, Roessger (2017, 2019) contributes to the conceptualization of self and meaning-making, synthesizing ideas from constructivism, pragmatism, and functional contextualism. Roessger (2019) proposes a taxonomy of reflective meaning-making based on data from a latent content analysis of three top adult education journals. He then describes the inconsistency in which the word “meaning making” is used throughout the adult learning literature and proposes three functional definitions: meaning making, meaning transformation, and reflective meaning transformation. Meaning making is when a person relates new experiences or a foreign concept to their prior knowledge. For example, when I learned how to play the guitar, I encountered the minor scale (unfamiliar), which I then related to notes (familiar) and melody (familiar). Meaning transformation is when a person relates a familiar concept to another familiar concept, thus transforming meaning by creating a new relationship. After taking a history class, an anti-imperialist activist may relate early American colonialism (familiar) with modern Western imperialism (familiar), creating a new relation and transforming meaning for both concepts. Finally, reflective meaning transformation relates familiar content to a person’s conceptualized self, thus changing the content and transforming the self. Consider Holly, whose religion unyieldingly forbids alcohol consumption. Holly has previously related this religious tenet to her conceptualized self. However, Holly visits another country, where faithful adherents to the same religion have no qualms about consuming alcohol. Holly suffers cognitive dissonance, where her concept of alcohol is at odds with her new experience. As a result, she reconsiders how this relates to her sense of self. She acknowledges that perhaps an aversion to alcohol consumption is related more closely to her cultural norms than her religious convictions. Accordingly, her conceptualization of alcohol changes. For Roessger, this is similar to meaning-making perceived within the adult education literature and suggests it is a

prerequisite for reflection. Holly's example demonstrates transformative change, in which the function of alcohol changes (from undesirable to acceptable) as well as the functional relationship between alcohol and herself (from "my religious beliefs prohibit drinking alcohol" to "my religious beliefs tolerate alcohol consumption").

Conceptualizations and studies of the self are prominent in cognitive psychology literature. Although a self-described "social behaviorist", George Herbert Mead, like James, influenced a conceptualization of self in various paradigms of psychology and sociology. Mead (1934) argues that language is essential for the development of self and that the self is ultimately a behavioral function of social interaction. Also, like James, Mead distinguishes between two forms of self, an "I" and a "me." The "I" is a response to the behaviors and attitudes of a person's social group, while the "me" is a set of organized attitudes that the person assumes from their social group. Furthermore, Mead views the self as a social process in which the attitudes and behaviors of others influence the self. He describes self-development in two stages: perspectives resulting from interpersonal or small group interaction and interaction with a "generalized other." The generalized other is a community with broader norms, beliefs, values, and attitudes. Because people often interact with different social groups, Mead theorizes that separate, interchangeable selves create a unitary self. The unitary self is the "I," but a person may adopt a different self—a "me"—to interact with other groups. While the "me" self is the organization of attitudes, multiple selves combine to form the "I" self, which is the self that is aware. Or, in other words, the "I" is the conscious self comprised of several "me" selves that exhibit personality traits, attitudes, and beliefs.

Similarly, the theory of mind is a prominent conceptualization of self that focuses on social behavior. Theory of mind is when a person "imputes mental states to himself and to others



(either to conspecifics or to other species as well)" (Premack & Woodruff, 1978, p. 515). Purpose and intent are states people impute most widely, such as belief, thinking, doubt, and trust.

Premack and Woodruff's (1978) seminal study on whether chimpanzees have a theory of mind sparked debate on whether this phenomenon is uniquely human. In one experiment, researchers showed a chimpanzee a video of humans struggling to obtain a goal familiar to the chimpanzee, such as reaching for a banana. The chimpanzee demonstrated she was able to correctly comprehend the problems in a subsequent activity in which she chose photographs of the correct solutions. The authors argue theory of mind explains this result. The chimpanzee imputes her state of mind to the humans in the video; she can make sense of the humans' problem.

In a second experiment, the chimpanzee watched videos of humans struggling with different problems less familiar to the chimpanzee. Humans were locked in a cage, struggling to ignite a heater, trying to work a phonograph that was unplugged, and run water from a hose unattached from a faucet. After watching the videos, the chimpanzee correctly solved all problems from a set of pictures, including using a key to unlock the cage and igniting a pilot light. Furthermore, the chimpanzee correctly chose 11 out of 12 photos that solved additional problems for the locked cage—the chimpanzee had to choose between a broken, twisted, and regular key and ignite the heater with a cone that was either lit, unlit, or burned down.

Additionally, the chimpanzee chose among a set of pictures illustrating a hose or electrical cord that was either cut, attached, or unattached. The authors argue the latter experiment demonstrates novel problem solving (the chimp never performed these actions herself). They argue further those additional problem-solving activities cannot be explained purely by associating physical properties. However, some remain skeptical that these experiments truly demonstrate a theory of mind outside of human consciousness. In a commentary on the Premack and Woodruff study,

Dennett (1978) describes the difficulty in designing an experiment that strongly suggests imputation of beliefs. He argues that the study does not isolate alternative explanations such as habit of mind. He concludes that an investigation would need to include a communicative element to convince him that chimpanzees can develop a theory of mind.

While theory of mind and the social construction of self have influenced self-concept in various paradigms, the information processing metaphor in cognitivism is the primary driver of many current theoretical models and research. Particularly, cognitive models focus on the role of memory as it relates to one's sense of self. A typical information processing model assumes working memory processes sensory experiences (visual, auditory, etc.) and provides temporary storage and manipulation. Working memory consists of a central executive directing sensory data to a visuospatial sketchpad or a phonological loop (Baddeley, 1992). It encodes relevant information into long-term memory through an episodic buffer, which acts as a two-way mediator between working memory and long-term memory (Heathcote, 2016).

Additionally, long-term memory is further categorized into semantic and episodic memory. Semantic memory is a collection of interrelated factual memories. For example, “tennis is a sport” is a simple declarative fact stored in semantic memory. Episodic memory, on the other hand, is a memory of past events. “In high school, I didn’t place in the district tennis tournament” is an example of episodic memory. While they are often discussed as different memory systems, there is overlap between the two. The semantic knowledge of “I didn’t place in the district tournament” is part of my episodic memory in which I experienced the event of not placing in the tennis tournament (Tulving, 1972, 1985). This distinction is similar to the unique nature of deictic relationships in relational frame theory. Deictic relationships are perspective-taking relationships—the consequence of phenomenological experience, whereas other

relationships are semantic. But, deictic relationships can semantically interact with other relationships.

Using an information processing metaphor, Rogers (1981) defines the self as "a prototype that contains a collection of features the person sees as describing him or her" (p. 196). The elements of the self prototype are traits, values, and memories of behaviors or events. Within a person's cognitive structure, the self influences the encoding of information in memory. Rogers assumes three empirical expectations to validate these claims. If the self is a prototype, expectations for memory recall include a false alarms effect—people who identify prior self-concepts will falsely believe new self-concepts were present along with the initial concepts. A second empirical expectation is the prototype effect—the response time between relating highly descriptive terms and highly non-descriptive terms to the self is higher than relating moderately descriptive terms. The final empirical expectation is enhanced memory for self-referent terms. People remember terms that describe themselves more than terms that do not. These empirical assumptions have significance for the self-reference effect, which I will discuss later.

Rogers further offers three models of the self as a cognitive structure: The Human Association Model, computational models focusing on information availability, and models incorporating affect. For Human Association Models, the self is a network of concepts joined by specific logical relationships, where recalling information about the self is accounted for by semantic memory. Computational models that focus on information availability claim self information is more readily available than other information, thus making information related to the self easier to recall. Finally, models incorporating affect place emotion as a moderator for recall of self information. Linville (1985) provides an example of the latter, suggesting that possessing multiple selves, as Mead theorized, provides a safeguard for affective disorders such

as depression. Furthermore, Rogers argues that the self as a cognitive structure is unique from other cognitive systems. He claims four special properties emerge from the cognitive self: (a) the self is largely immutable—aspects of the self will not change; (b) the self is likely the most significant prototype among other cognitive prototypes; (c) the self has a vital affective component; (d) the self may assist in encoding information about others. Others working within a cognitive framework have similar perspectives.

Kihlstrom et al. (1988) define the self as “a person's mental representation of his or her personality” (p. 146). Mental representations divide into two classes: perception-based and meaning-based. Perception-based representations are extracted from spatial and temporal information and are processed by the sensory-perceptual system—that is, we use our senses to understand the world. Meaning-based representations are associations between objects and events abstracted from stimulus information. Research focuses primarily on meaning-based representations. Meaning-based representations are distinguished into the “self as a list structure” and the “self as a memory structure.” The self as a list summarizes self characteristics, while the self as a memory structure is represented as a node on a graph encoded in propositional form—much like a concept map. Influenced by James, Kihlstrom et al. distinguish the meaning-based representation as self as object. The authors conceptualize the self as object within a series of nodes, with the self at the center and each node in semantic or episodic memory connected to the self—either directly or indirectly. According to the authors, episodic memory has a profound effect on memory and the self. They write:

“Especially when one considers the scope of autobiographical memory [episodic memory about one’s behavior], it would seem reasonable to conclude that the self is one of the richest, most elaborate knowledge structures stored in memory. One implication of this conclusion is that stimuli processed for self-reference should be highly memorable” (p. 150).

Kihlstrom et al. are careful to note that the self is not monolithic; there are likely more selves within a normal range of personality. They suggest people possess cognitive flexibility when describing themselves. Coincidentally, the RFT-based Acceptance & Commitment Therapy (ACT) approaches personality with a similar perspective through its concept of “psychological flexibility” (Ciarrochi et al., 2010).

Also following James, Klein (2012a) argues for distinctive selves. He distinguishes between the ontological self—the self of perception—and the epistemological self—the self of description. The ontological self is primarily a philosophical issue and is difficult to study, whereas the epistemological self is amenable to scientific study. The ontological self is consciousness and perspective. It is consistent and always on, apart from unconscious states such as sleep or coma.

On the other hand, the epistemological self is in constant flux due to experience, although some aspects remain primarily stable, such as long-term memory and identity traits. The epistemological self is divided into several areas. It consists of:

- Episodic memories of one’s life events
- Semantic summary representations of one’s personality traits
- Semantic knowledge of facts about one’s life
- An experience of continuity through time: The current “I” connects to all previous “I’s” in a person’s life, influenced by episodic memory.
- A sense of personal agency and ownership
- The ability to self-reflect
- The physical self: The ability to represent and recognize one’s body
- The emotional self: The ability to experience and produce emotional states

These sources are functionally independent; they work together but can reduce to their individual components without removing a person's perspective. Klein and Nichols (2012) demonstrate this from a case study of a man suffering from retrograde amnesia due to an accident. The man could recall certain memories, but he described them as though the memories were not his own. The authors concluded that episodic memories provide a sense of identity continuity. However, self-traits in semantic memory still exist when a person has suffered amnesia. Additionally, episodic memories of previous events can still exist within the context of a system of interrelated memory processes but are stripped of personal ownership and agency.

Drawing on a different conceptualization of self and memory, Conway (2005) proposes the Self-Memory System (SMS). Within the SMS, he identifies two properties of memory: coherence and correspondence. Coherent memories may be altered, distorted, or fabricated to be consistent with a person's perceived self, goals, and desires. Correspondent memories, on the other hand, are reflective of a person's true experience. These memories are encoded to balance one's sense of self. The brain encodes correspondent memories for efficiency, which Conway suggests was a necessary evolutionary development. A person needs to remember if a location is a lion's den to avoid danger, for example. However, coherent memories are encoded and conformed to reinforce a person's identity and perceived self. A person may remember an altercation differently than reality because it reinforces the person's sense that they are reasonable and coolheaded.

The relationship between sense of self and memory is not only conceptual but also supported by empirical evidence. In one experiment, Dunkel and Lavoie (2005) examined the link between identity formation and recall. They used Marcia's (1966) conceptualization of Erikson's (1959) developmental model, categorizing identity formation into four areas: identity

achieved, identity moratorium, identity foreclosure, and identity diffusion. People who are “identity achieved” have actively explored their identity—questioning and searching for one's beliefs and goals—and have committed to making firm decisions about those beliefs and goals. People in “identity moratorium” are currently exploring beliefs and goals without committing, while people in “identity foreclosure” have committed to beliefs and goals without actively exploring them. Finally, those in “identity diffusion” have neither explored nor committed to beliefs or goals. A total of 195 undergraduate students aged 18-24 participated in the study. Participants judged the relevancy of trait adjectives to themselves and were later tested on their recall of the adjectives. Dependent variables were decision times of the judgment, confidence in the judgment, the number of adjectives correctly recalled, and the number of adjectives falsely recalled (intrusion). The independent variable was identity status. Researchers used the EOM-EIS-2 to classify participants into the four identity statuses. They placed participants into the corresponding identity status if a participant scored one standard deviation above one of the identity statuses and one standard deviation below the other three. After this procedure, 93 participants who fit into the four identity statuses remained in the study. Trait adjectives were selected based on Anderson's (1968) list of personality-trait words. Each adjective had a likeability score between two and four out of five to control for extreme positive and negative connotations. Additionally, the adjectives had a meaning score of at least 3.5 out of 4 to ensure participants understood the adjective's meaning. The experiment consisted of 48 trials. The trials were conducted by software which asked participants if a trait adjective described them, requiring a yes or no response by the participant. Response latency was measured by the software. Additionally, participants answered how confident they were of their response on a 1 to 5 scale. Each trial was randomized. After the trials, participants were instructed to perform

arithmetic problems for two minutes as a distractor. Participants were then asked to write down as many adjectives as they could remember within a three-minute time span.

The researchers conducted a factorial ANOVA for each dependent variable. The identity statuses were collapsed into a dichotomous variable indicating identity exploration (high achievement and moratorium; low foreclosure and diffusion) or identity commitment (high achievement and foreclosure; low moratorium and diffusion). The dependent variables relevant to this study are recall and intrusion. For recall, there was an interaction effect between response type (yes/no) and identity,  $F(1, 89) = 6.66, p < .01, \eta^2 = .07$ . The commitment group who identified a higher rate of self-descriptive traits recalled significantly more self-referential adjectives than non-self-referential adjectives. An additional ANOVA was performed on the number of intrusions, with a significant main effect for identity,  $F(1, 89) = 11.04, p < .001, \eta^2 = .11$ . The exploration group committed more intrusions than the committed group. The findings indicate that those with a "committed" identity recalled more self-referential trait adjectives than non-self-referential trait adjectives, while there was no significant difference with the "exploratory" identity. Findings suggest that people who have examined and committed to their identity can recall more self-referential words than those who have examined—but not committed—to their identity. In other words, those with a stronger sense of self are more likely to recall self-referential words.

**Reflective aptitude.** In discussing the self and memory, it follows that a person's ability to reflect on their thoughts and actions—to develop one's observable self—may moderate the self-reference effect. Reflection dominates much of adult learning literature, from pinpointing its definition to arguments on its effectiveness as a learning strategy (Michelson, 2011; Roessger, 2017). Using an RFT approach, reflection is built on meaning-making (see Roessger, 2019),



transforming relationships between a person's self, thoughts, and experiences. As previously discussed, perspective-taking, or deictic, relationships have spatial and temporal relations. For example, *I am here* and *you are there* is a spatial perspective. *I am going* to the kitchen (in the present), but *I was* in the bedroom (in the past) is a temporal perspective. Reflection is functionally defined when a person makes meaning by establishing complex relationships between deictic relations and antecedent relations (Roessger, 2017). Therefore, by relating oneself to concepts, self-reference in concept mapping is arguably a type of reflective activity. This subsection examines the literature on reflection in the broader education and adult learning literature while also drawing on relevant interdisciplinary theoretical and empirical works.

Scholars often cite Dewey as conceptualizing reflection in human psychology and educational practice (Clarà, 2015; Jordi, 2011; Michelson, 2011; Roessger, 2017). While Dewey's concept of reflection is present in multiple works, he explores his preliminary ideas in *How We Think*. As a pragmatist, Dewey (1910) defines reflection as consequential thinking. It is not merely daydreaming or idle thoughts but rather a purposive response to a dilemma, causing a person to consider a course of action. Dewey refers to this dilemma as the "fork in the road." A person suspends their preconceived judgment as they confront the dilemma and engage in further inquiry.

Rodgers (2002) further expands on Dewey's conceptualization of reflection and aims to synthesize and clarify his ideas found throughout his works. She notes that reflection is ill-defined, but a working concept of reflection is present in Dewey's writings. For example, Dewey writes that reflection's function is to make meaning—to facilitate relationships between experiences. He conceptualizes the process of reflection as analogous to the scientific method, providing six phases of reflection which Rodgers further condenses into four. These four steps

offer a linear, methodic approach. First, a person has an experience. Second, the person attempts to describe the experience. Third, after the person successfully describes the experience, they analyze the experience. Finally, based on the analysis, the person makes an informed, intelligent action from their experience. Furthermore, based on explicating Dewey's writings, she posits the following criteria for reflection:

1. Reflection is a meaning-making process that moves a learner from one experience into the next with deeper understanding of its relationships with and connections to other experiences and ideas. It is the thread that makes continuity of learning possible, and ensures the progress of the individual and, ultimately, society. It is a means to essentially moral ends.
2. Reflection is a systematic, rigorous, disciplined way of thinking, with its roots in scientific inquiry.
3. Reflection needs to happen in community in interaction with others.
4. Reflection requires attitudes that value the personal and intellectual growth of oneself and of others. (p. 845)

According to Rodgers, Dewey argues that not everyone is skilled in reflection. She writes, "...an additional quality is necessary in the person—a quality of being present to the nature of the experience and an openness to its potential meanings" (p. 850). However, Dewey notes that reflection is a skill to be learned. Considering a person's ability to reflect, he suggests four attitudes that a learner needs to possess. First, learners need to approach a subject with "whole-heartedness." They must be open to new experiences and have a sense of curiosity. Second, learners must be direct with themselves; they must be self-aware. Third, learners should have an open mind and be critical thinkers. They should have the ability to entertain different perspectives and challenge beliefs—like Kegan's (2009) final phase of selfhood in which a person can engage in dialectical thinking. Finally, learners must develop intellectual responsibility, the ability to act on new meaning.

Dewey's conceptualization of reflection is highly influential in the literature. Reflection as a meaning-making process and a learner's ability to reflect are relevant concepts to this study.

Although Dewey, and specifically Rodger's interpretation of Dewey, connotes a constructivist approach to reflective thinking, his conceptualization aligns well with an RFT perspective as identified by Roessger (2017). I will discuss the conceptual RFT literature on reflection later. For now, discussion is warranted on other approaches prominently used in education and psychology.

While Freire is often associated with critical pedagogy, his vision of emancipatory education has contributed significantly to educators' conceptualizations of reflection (Elbaz, 1988; Kitchenham, 2008; Mezirow, 1998). Freire (2000) discusses reflection within a humanistic and revolutionary framework. Reflection, along with action, is necessary for emancipatory education. Freire considers this "praxis." Educators seeking to teach praxis must not come to the oppressed as a savior but make learners aware of their situation through dialogue. They must understand the power dynamics of discourse and seek to ensure all involved in dialogue are equal. Through dialogue, educators must pose the present situation as a problem so that the oppressed are challenged, thus eliciting a response of reflection and action. Together, educators and learners work as a group to change their existing reality. Freire's concept of praxis echoes Dewey's fourth criterion of reflection for learners: they must not only be exposed to new meaning, but make sense of it and, importantly, act upon it.

Freire makes humanist assumptions toward emancipatory learning; educators must challenge learners to engage in reflection and action to realize emancipatory goals. However, educators do not provide direct teaching—Freire calls this "banking education"—as he considers this oppressive pedagogy. Rather, Freire's conceptualization of reflection and education is similar to andragogy's assumptions (Knowles, 1970) with a revolutionary bend. As such, Freire acknowledges reflection as part of the human condition and remarks that, unlike other animals, humans have a sense of temporality and consciousness. "Humans, however, because they are

aware of themselves and thus of the world—because they are *conscious beings*—exist in a dialectical relationship between the determination of limits and their own freedom” [emphasis in original] (p. 99). According to Freire, we are inherently reflective because we are self-aware.

Freire’s impact on reflection is most noticeable within transformative learning theory. Like Dewey, Mezirow (1990) describes reflection not as mere “thinking” but rather examining one’s presuppositions. He argues that learners have "meaning perspectives," typically formed through childhood by one's environment, either through cultural assimilation or verbal learning. A learner's meaning perspective causes them to form “habits of expectation” through their everyday life. Mezirow defines a habit of expectation as the disposition and capability involved in making sense of everyday experiences. When a habit of expectation is disrupted, the opportunity for reflection occurs. He writes that reflection happens in both instrumental and communicative learning. Instrumental learning is typically procedural and is a derivative of the hypothetico-deductive method. This type of learning can be observed and verified by empirical methods. He argues that most learning falls in this category. Communicative learning, on the other hand, involves changing meaning perspectives through critical discourse. Drawing on the work of Habermas (1984), Mezirow claims that empirical methods do not verify changes in meaning perspectives. Instead, these changes are validated by a consensus determined by cultural and societal norms. Mezirow also claims that distortions—epistemic, sociocultural, or psychic—may inhibit critical reflection. His communicative learning is like Freire’s dialogic reflection, where educators engage learners in reflection through dialogue. Transformative learning is predicated on this concept. Mezirow (1997) writes:

To facilitate transformative learning, educators must help learners become aware and critical of their own and others’ assumptions. Learners need practice in recognizing frames of reference and using their imaginations to redefine problems from a different perspective. Finally, learners need to be assisted to participate effectively in discourse.

Discourse is necessary to validate what and how one understands, or to arrive at a best judgment regarding a belief. In this sense, learning is a social process, and discourse becomes central to making meaning (p. 10).

In later works, Mezirow (1998) elaborates on critical reflection and distinguishes between the Critical Reflection of Assumptions (CRA) and Critical Self-Reflection of Assumptions (CSRA). Interestingly, this article takes a pragmatic approach to critical reflection and discourse, noting that reflection does not transcend the empirical world of change but rather is a consequence of inquiry. He argues that critical reflection tends to work better than alternative options, such as understanding based on authority and tradition. These two areas of reflection parallel instrumental and communicative learning. CRA is objective reflection and aligns with instrumental learning, while CSRA is subjective reflection and aligns with communicative learning. Objective reflection examines, questions, or reframes a problem; it challenges the validity of discourse. On the other hand, subjective reflection is introspective; it examines one's presuppositions, such as beliefs, morality, and emotional behavior.

Similarly, Brookfield (1991) also advocates for critical reflection. He synthesizes the adult education literature on critical reflection and lists takeaways for critical reflection as an adult learning theory. He describes four "clusters" in adult learning where critical reflection is discussed. In the adult education literature, critical reflection discourse is clustered by a) how learners arrive at critical reflection in everyday life, b) how adults evolve a critical awareness of oppression and develop through emancipatory learning, c) how adults learn to learn—how they think and what is knowable, and d) how they reflect in organizations and the workplace. Next, he discusses key components of reflection theories and frames them as a process. A person engaging in critical reflection is (a) prompted by an event, usually described as disorienting or dissonant; (b) experiences feelings of depression and self-scrutiny; (c) seeks out others with similar

experiences; (d) actively comes to terms with the discomfort; (e) makes meaning of the experience; (f) tests new identities, beliefs, values, and actions to fit with their new meaning; (g) and, seeks ways to integrate the changes into their lives permanently, perhaps through self-affirmations or tentative commitments, thereby creating a feeling that a true identity is realized.

Moreover, Brookfield (2016) distinguishes between reflection and critical reflection. He notes that reflection alone focuses merely on the “nuts and bolts” of the process. For reflection to be critical, a person must question “the criteria, power dynamics and wider structures that frame a field of practice” (p. 13). Brookfield derives critical reflection from two philosophical paradigms—pragmatism and critical theory. The pragmatic approach to critical reflection emphasizes challenging assumptions, testing new ideas, and focusing on the consequence of reflective action. In explaining the pragmatic approach, he describes a critically reflective practitioner:

The exemplary practitioner is held to be one who constantly seeks out new information and is open to taking new perspectives on her practice. She solves problems by comparing experiences with peers, inviting critique of her efforts, and continually checking and revising her assumptions. This is the essence of American pragmatism—the intentional and experimental pursuit of beautiful consequences (p. 15).

Additionally, drawing on the works of Marx, Gramsci, Freire, and others, Brookfield aligns critical reflection closely with critical theory. Here, he argues that critical reflection ought to expose ideologies embedded in everyday life. Critical reflection for the practitioner aims to uncover hegemonies masked by oppressors who subtly manipulate social and cultural values to keep the status quo. Thus, the oppressed are deceived into believing the current social order is in their best interest. Brookfield discusses vocation as an example. A teacher who increasingly devotes time to their students is considered a good teacher—a socially desirable action. However, to the detriment of the overworked teacher, administrators benefit from this value as

they can cut budgets and personnel, relying more on the teacher who has normalized picking up the slack. Critical reflection is highly influential in the adult learning literature. However, other conceptualizations of reflection more suited to instrumental tasks are prominent in the literature as well.

Taking a developmental and constructivist perspective, King and Kitchener (2004) frame reflection as “reflective judgment.” They previously proposed seven stages of reflective judgment, which they have since condensed into three areas of reflective maturity: pre-reflective thinking, quasi-reflective thinking, and reflective thinking. Pre-reflective thinking is when people accept ideas and facts without critical examination. On the other hand, Quasi-reflective thinkers acknowledge uncertainty as part of knowing and accept that knowledge is constructed. Evidence is understood to be a key component of reasoning. At peak reflective maturity, people are reflective thinkers who use evidence and reason to evaluate facts and ideas. They frame arguments within context and examine coherence and consistency. The authors have developed tools to research reflective judgment, including two interview tools—the Reflective Judgment Interview (RJI) and the Prototypic Reflective Judgment Interview (PRJI)—and a questionnaire, the Reasoning about Current Issues (RCI) test. With decades of using these tools, they argue their research supports the Reflective Judgment Model. As reflection lacks definitional clarity, King and Kitchener’s reflective judgment further obfuscates the reflection literature. Reflective judgment is arguably more akin to critical thinking than other definitions of reflection. Rather than evaluating knowledge as it pertains to oneself, the final stage of reflective maturity is merely the ability to use evidence and reason to evaluate ideas.

Others have described reflection as part of experiential learning. Schön (1983) proposes “reflecting-in-action” as an alternative to technical rationality—the act of applying scientific

methodology to problem-solving. He describes reflecting-in-action as acting on tacit knowledge while doing something. Reflection-in-action is, therefore, intuitive thinking whereby people make decisions during the act. Schön exemplifies this with jazz musicians:

When good jazz musicians improvise together, they also manifest a ‘feel’ for their material and they make on-the-spot adjustments to the sounds they hear. Listening to one another and to themselves, they feel where the music is going and adjust their playing accordingly (p. 55).

He further applies reflection-in-action to the professions and work. Design professions habitually employ reflection-in-action. A designer examines a work and offers a critique often derived from tacit knowledge of aesthetics and form. Schön writes particularly about architecture and the changes that come from the actual work of designing. A parallel is also in graphic design education. Lee (2010) frames critique within a dialogic reflective process. First, she separates critique into two areas: technical feedback and value judgments. Technical feedback is based on the form and structure of the work, following principles of aesthetics. In contrast, value judgments derive from the work’s context and aims. Students evaluate and reflect as they build and refine their work, beginning with a broad conceptualization and ending with the details.

Schön focuses significantly on how managers engage in reflection-in-action. He argues that there are unique features of a manager’s reflection-in-action, as they consistently face challenges that require intuitive decision-making and reflection on outcomes. Additionally, managers have the benefit of drawing upon an organization’s knowledge. Schön, along with his long-time collaborator Argyris, also proposed that organizations reflect on their practices. They define this action as “double-loop learning.” Double-loop learning is the ultimate goal in Argyris and Schön’s organizational learning model and parallels higher-order learning for the individual (Argyris & Schön, 1996). However, Schön’s conception is met with criticism in adult education. Usher, Bryant, and Johnston (1997) argue that Schön did not use reflection-in-action in his own



work. Instead, practitioners misinterpreted reflection-in-action in his studies, using it as technical dialogue and process (Merriam et al., 2007). Paradoxically, Lipshitz (2000) argues that Argyris and Schön's organizational learning model does not provide enough technical substance demonstrating how to achieve double-loop learning.

Kolb (2015) has also argued for reflection as a part of experiential learning. His experiential learning theory derives from Lewin, Dewey, and Piaget, influenced by the pragmatism of James, the reflection of Jung, the humanism of Maslow and Rogers, and the radical ideology of Friere and Illich. Kolb's model provides a holistic integration between experience, perception, cognition, and behavior. He outlines several characteristics of experiential learning, stating that (a) learning is best conceived as a process, not an outcome; (b) learning is a continuous process; (c) learning requires the resolution of conflicts; (d) learning is a holistic process of adaptation to the environment; (e) and, learning is the process of creating knowledge. Kolb argues that four abilities comprise an experiential learning cycle: concrete experience, reflective observation, abstract conceptualization, and active experimentation. Kolb labels the categories of reflective observation and abstract conceptualization as "assimilative" and concrete experience and reflective observation as "divergent." Roessger (2013, 2014) argues that learners adept in these abilities have a high propensity for reflection.

Boud et al. (1985) present a model of reflection that emphasizes past experiences and the affective domain. They argue that the process of reflection is (a) active and centers on a learner's prior experience; (b) how that learner integrates new knowledge with prior experience; (c) how it assimilates based on the aims of the learner; (d) and, how the learner re-evaluates the experience both cognitively and affectively. Boud et al.'s model demonstrates the reflection process as an interchange between a person's behavior, ideas, and feelings and the actual reflective process.

The reflective process includes revisiting past experiences and removing negative or obstructive associations with those experiences, with outcomes of new perspectives, a change in behavior, or commitment to action. While the model is simple, its emphasis on context and transformation parallels Roessger's conceptualization of reflection.

Roessger (2017) proposes a synthesis between Rodger's interpretation of Dewey's meaning-making criterion and an RFT account. He discusses how learners build knowledge through creating relationships. Mainly, reflection includes relating concepts to the self. When confronted with new experiences, the integration of the "I," with its prior relations, creates incongruity or no meaning. It serves as a catalyst to contextually change existing relationships and adjust to the new content. Therefore, he defines meaning-making in reflection as "relating an event in a relational network containing the self to an event in an analogous network, under the antecedent control of either incongruous meaning or a request to reconsider meaning" (p. 88). His operational definition of reflection's meaning-making process provides a foundation for empirical study. As previously mentioned, Roessger (2019) further elaborates on his conceptualization of meaning-making, suggesting three phases: one that relates new concepts with others, one that changes the function between concepts, and one that changes the function between concepts and the self.

Reflection is not only of interest in education but also in psychotherapy. Grant (2001) examines self-reflection within the construct of *psychological mindedness*. Psychological mindedness encompasses a person's ability to engage in metacognitive activities—to see one's thoughts and emotions and understand one's behavior. Grant further defines it as "...a predisposition to engage in acts of affective and intellectual inquiry into how and why oneself and/or others behave, think, and feel in the way that they do" (p. 12). To measure psychological

mindedness, Grant developed the Self-Reflection and Insight Scale (SRIS). The purpose of the SRIS is two-fold: to evaluate one's ability to engage in reflective inquiry and evaluate one's perception of other's behavior. Although he developed the SRIS to measure psychological mindedness, the ability to engage in self-reflection—reflective aptitude—is a crucial component and subscale. The self-reflection subscale aligns with the study's goal of assessing reflective aptitude: measuring one's intellectual and affective capability to engage in reflection.

Grant views reflection as pivotal to a model of self-management, in which a person sets goals, develops plans, acts on those plans, monitors and evaluates action, and makes necessary adjustments. Like reflection-in-action, this model emphasizes the ability to make changes during action. However, Grant argues that self-reflection is a cognitive ability that can be measured to determine reflective aptitude. To validate the SRIS, Grant et al. (2002) divided the scale into “self-reflection” and “insight” subscales, with “self-reflection” further divided into “engagement in self-reflection” and “need for self-reflection.” The authors conducted a study with undergraduate students ( $N = 267$ ) to determine an optimal factor solution for the subscales and investigated congruent validity and test-retest reliability. Conducting a principal components analysis, the authors attributed the latent variable “self-reflection” to twelve questions that loaded on one factor ( $\alpha = .91$ ) and “insight” to eight questions that loaded on the second factor ( $\alpha = .87$ ). The subscales were titled SRIS-SR and SRIS-IN for self-reflection and insight, respectively. A second study demonstrated favorable test-retest reliability for the SRIS-SR ( $N = 28$ ,  $r = .77$ ,  $p < .001$ ). In a third study, the SRIS-SR scale was validated against a previously developed self-reflection scale, the Private Self-Consciousness Scale (PrSCS), with a significant positive correlation ( $N = 127$ ,  $r = .59$ ,  $p < .001$ ). Overall, they found no differences between gender but a positive correlation between self-reflection and age.

In sum, reflection is an ill-defined concept. Conceptually, the literature perceives reflection as nearly synonymous with critical thinking and problem solving (Dewey, Schön, King and Kitchener), critically evaluating one's actions (Mezirow, Brookfield, Grant), an experiential process (Schön, Kolb, Boud, et al.), part of emancipatory learning (Freire, Brookfield), and a functional relationship between the self, knowledge, and experience (Roessger). As Rodgers (2002) and Roessger (2017) demonstrate, reflection struggles as a studied construct due to its lack of operationalization. However, many conceptualizations—particularly those for critical reflection—have several commonalities: emphasis on the transformation of the self, reflection as more than rumination, and the formation of new associations between experience and the self. In a systematic review, Van Beveren, Roets, Buysse, and Rutten (2018) examined 42 conceptual and empirical articles on reflection in teacher education, social work, and psychology. They concluded that reflection was often vague but determined two prominent branches of conceptualization: rational-technical reflection and critical-emancipatory reflection. The authors state that the most recent literature is based on a critical-emancipatory perspective.

The link between self-reflection and the self-reference effect is mainly conceptual. Reflection is intimately related to the self and the ability to find meaning between the self and knowledge. Reframing Dewey's first criterion of reflection within an RFT perspective, Roessger's (2017) conceptual definition is "relating an event in a relational network containing the self to an event in an analogous network, under the antecedent control of either incongruous meaning or a request to reconsider meaning" (p. 88). This study uses this conceptual definition of reflection; however, no one has explicitly created an assessment for this conceptualization. Therefore, the SRIS-SR is used to measure a learner's aptitude for reflection. Both Grant's and Roessger's conceptualization stems from the rational-technical perspective of reflection. While

Roessger's conceptualization derives from behavior analysis, which assumes causal environmental mechanisms for behavior, Grant's instrument measures the same construct despite the difference in theoretical orientation.

**Self-reference effect.** Symons and Johnson (1997) define the self-reference effect as “the mnemonic superiority from relating material to the self” (p. 371). The effect results from forming connections encoded in memory to events that have occurred in one's personal experiences (Rogers et al., 1977; Warren et al., 1983). The self-reference effect can be traced to the psychological study of memory (Ebbinghaus, 1913) and the distinction between semantic and episodic memory (Tulving, 1972). The distinction between semantic and episodic memory is important, particularly since autobiographical memory is part of episodic memory, yet concept mapping in common usage utilizes semantic memory. However, recent research suggests that autobiographical elaboration—the act of connecting one's self to concepts—uses both memory systems (Klein, 2012b).

Tulving (1985) argues for distinguishing semantic and episodic memory by outlining the differences and similarities. Semantic memory is when an individual associates an object or concept with another object or concept. Episodic memory, by comparison, is when a person experiences a sequence of events. A person can travel back in time through their episodic memories, while semantic memory is static. Although episodic memories can include semantic memories, the episode itself is still distinct. For example, if a person was to learn that a German Shephard is a type of dog in a conversation with a friend yesterday, the person has made a semantic relationship between German Shephard and dog. Nevertheless, the episodic memory of having a conversation with a friend yesterday is distinct from the association between German

Shepherd and dog. While Tulving argues that semantic and episodic memory are distinct systems, he concedes an interdependence between the two.

In their seminal study, Rogers, Kuiper, & Kirker (1977) studied the self-reference effect on the encoding and recall of personal information. They argue self-reference as a powerful encoding device that exceeds other encoding devices, including semantic encoding. In one experiment, 32 participants in an undergraduate psychology course responded to four cue questions when given a descriptive word. Researchers asked participants about the structure of the word, whether the word rhymed with another word (phonemic), whether the word was related to another word (semantic), or whether the word described the participant (self-reference). After responding to the words, they tasked participants with recalling the adjectives by writing them on paper. The authors conducted a two-way ANOVA and found a significant interaction between the rating task (the question type) and the rating (the participants' yes/no response) on recall,  $F(1, 31) = 4.22, p < .05$ . The interaction indicated greater recall for words with a yes rating on self-referent words,  $t(31) = 2.62, p < .05$ .

To further distinguish between semantic encoding and self-referent encoding, the authors conducted a second experiment. In this study, 27 participants were given trait words and asked the same four types of questions. However, rather than compare the trait words against other words, they were asked to rate (yes or no) how the words sound or feel. For example, the phonemic question asked participants to rate whether the word had a rhythmic or lyrical sound. The semantic question asked participants if they felt the word was meaningful to them. The self-reference question, however, still asked participants whether the word describes them. Additionally, the procedure was conducted in a group rather than an individual setting. After 40 trials, researchers asked participants to recall the adjectives. The authors conducted an ANOVA

and found a main effect of rating task (cue questions),  $F(3, 78) = 4.20$ ,  $p < .01$ , and a significant semantic/self-reference recall difference,  $p < .05$ , with a higher recall of self-referential words.

While the Rogers et al. study was not the first to suggest the self was pivotal in memory encoding, it was the first to provide persuasive evidence that self-referential encoding was superior to semantic encoding.

Recent studies continue to validate the self-reference effect. Some examine the mental and neurological mechanisms of self-reference, while others question whether self-reference is superior to other-reference encoding, particularly when the other is a close family member or friend (Kihlstrom et al., 1988). For example, would I be able to recall traits descriptive of my sister as well as I recalled traits about myself? In a meta-analysis of studies from 1974 to 1994, Symons and Johnson (1997) conclude that overall, self-referent encoding has a moderate effect (Cohen's  $d = .45$ ) on retrieval than other encoding types. Compared to semantic encoding, self-reference had a larger effect size,  $d = .59$ . However, compared to other-reference encoding, self-reference had a slightly smaller effect size,  $d = .26$ . They also found that studies that used trait words rather than nouns had a greater effect size. Studies throughout the 1970s and 80s often yielded contradictory results. For example, some studies confirmed that elaboration with nouns induced the self-reference effect while others did not.

Considering the historical literature and Symons and Johnson's (1997) meta-analysis, Klein (2012b) argues that self-reference effect research led to mixed results because researchers studied different functions of the self. He argues that the epistemological self—the self that is open to scientific study—is multifaceted. Based on neuroanatomical studies, he suggests the epistemological self contains several functionally different systems, such as autobiographical memory, semantic representations of personality traits, continuity of phenomenological

experience, a sense of agency, and the ability to reflect, among others. Klein et al. (1989) previously theorized that the self-reference effect was a result of multiple mechanisms. In a series of studies, they concluded that relating traits and relating autobiographical memories to cues used different cognitive processes. The study concluded that both contribute to the self-reference effect.

Research on the self-reference effect within the past ten years has mostly focused on neuroanatomical correlates. For example, several studies suggest that the self-reference effect correlates with the medial prefrontal cortex (Macrae et al., 2004; Philippi et al., 2012; Yaoi et al., 2015). Studies outside of neuroscience typically focus on specific populations or extensions of the self-reference effect. Cunningham et al. (2014) found that the self-reference effect is robust in children as young as four years old, and Lombardo et al. (2007) found that the self-reference effect is absent in people with autism. Research also found that people with chronic depression are more likely to recall negative traits than positive traits (Wisco, 2009). Additionally, recent studies suggest that the self-reference effect can extend to narrative information (Carson et al., 2016; Grilli & Glisky, 2010) or visuospatial abstractions (Sui & Humphreys, 2015).

Few studies have examined the self-reference effect on transfer. Moreno and Mayer (2000) conducted a series of experiments examining how self-reference affects multimedia learning. The multimedia learning programs provide instruction on various topics throughout each experiment, followed by a recall test and a transfer problem-solving test. Participants were exposed to either a “personalized” group or a “neutral” group in all experiments. Researchers told participants in the personalized group to place their perspectives within the instruction. For example, the first experiment provided instruction on how lightning forms. One of the statements from the personalized group was, “As you watch, you tilt your head skyward. Your cloud's top



extends above the freezing level, so the upper portion of your cloud is composed of tiny ice crystals” (p. 732). The neutral group, however, only received instructions in the third person. Each experiment presented content in either audio or visual mediums. In all five experiments, researchers used t-tests to determine how well each group performed on the recall and transfer tests. In all five experiments, the personalized group outperformed the neutral group on the transfer tests.

The previous study is an example of the proxy effect of self-reference and is sometimes called “the personality effect” (Allan et al., 2017). It suggests self-reference, albeit by proxy, aids in learning transfer. Additionally, some evidence links self-reflection as a moderator for the self-reference effect. Sinatra et al. (2014) found that the psychological construct, “Need for Cognition,” has a moderating effect on self-reference in various performance tasks. The higher a person’s Need for Cognition, the more they benefit from self-reference. While Need for Cognition and reflection are conceptually similar, Berzonsky and Sullivan (1992) discovered a positive correlation between the two. Additionally, Grant (2001) suggests Need for Cognition is likely associated with psychological mindedness. In Grant’s framework, self-reflection is part of psychological mindedness. As self-reference in concept mapping is arguably a reflective activity, reflective ability is likely to have a moderating role.

The self, a person’s sense of self, and self-reflection are intricately tied together. Regardless of theoretical orientation, the literature suggests that the development of the self is crucial for higher-order thinking, which undoubtedly influences various learning outcomes. Because of the close relationship between these variables, I investigate sense of self and reflective aptitude as potential moderators for self-reference.

### ***Relational Ability***

Relational ability likely acts as a moderator and possibly a mediator in the study. As it is linked to cognitive ability (Cassidy et al., 2010; O’Hora et al., 2008), the literature suggests relational ability is a potential mediator for learning transfer. Additionally, concept mapping is a relational exercise; therefore, relational ability likely moderates a learner's capability to construct a concept map. While RFT researchers typically eschew the concept of a unified general intelligence, such as Spearman’s *g*, they conceptualize cognitive abilities associated with intelligence, such as analogical, deductive, and inductive reasoning, as the ability to form complex relationships. Therefore, testing for relational ability provides a different perspective for testing cognitive abilities. Outside of relational frame theory, researchers have examined the association between relational ability and educational outcomes. Dumas et al.’s (2013) literature review suggests that many studies indicate a correlation between relational ability and academic success in various contexts. However, they caution that further research needs to investigate interventions that influence relational ability. Currently, there is particular interest in developing relational ability to improve cognitive ability (Cassidy et al., 2011, 2016; Colbert et al., 2017). This is an exciting area of research, although similar studies within cognitive psychology have shown inconclusive results (Heugten et al., 2016). Regardless, there is a conceptual link that relational ability will moderate concept mapping quality and possibly mediate the relationship between concept mapping and transfer.

### **Theoretical Framework**

Although concept mapping derives from a constructivist paradigm, adult educators have framed concept maps within other theoretical and philosophical perspectives. Yelich Biniecki and Conceição (2016) suggest three additional frameworks for teaching concept mapping:

cognitivist, transformative, and social learning. They claim these three, along with the constructivist paradigm, offer diverse opportunities for critical analysis. However, Roessger et al. (2018) successfully used relational frame theory as a concept mapping framework, empirically validating it as a valuable perspective for concept mapping studies and instruction. This section describes the philosophy behind relational frame theory—functional contextualism, the essentials of relational frame theory, and how this study contributes to this theory.

Functional contextualism is a pragmatic and behavior-analytic philosophy with aims of prediction and influence, describing events with precision, scope, and depth (Hayes & Long, 2013). As a philosophy of science, it stems from one of Pepper's (1942) four "world hypotheses"—contextualism. Pepper developed his world hypotheses by categorizing the perspectives of his time, devoid of minutiae and progenitor idiosyncrasies. Each world hypothesis has a distinctive "root metaphor" that captures the essence of the philosophy. For contextualism, the root metaphor is the "historical event," or as Hayes et al. (1988) would later call it, the "act-in-context." The act-in-context is an action within a contextual environment, acknowledging the event and actors' cultural, historical, and social context. For example, Miguel is answering a test question in his English as a Second Language (ESL) class. In this situation, the act-in-context is Miguel answering the question. Of course, Miguel is likely doing other things as well. He may be daydreaming or listening to the cacophony of keyboard clicks. The act-in-context is whatever the scope of analysis dictates. With Miguel answering a question as the act-in-context, we must acknowledge Miguel's experiences of taking tests in the classroom—here and now—and how they relate with his contextual history. In studying human behavior, functional contextualists recognize that all actions are acts-in-context, including the actions of the researcher (Biglan & Hayes, 1996).

Contextualism is an inherently pragmatic philosophy, drawing on the American pragmatism of Pierce, James, and Dewey. Hayes et al. (1988) approach contextualism with distinctive ontological and epistemological stances. Rather than wading in arguments on the nature of reality, contextualists adopt an a-ontological position. That is, they do not concern themselves with arguments on the nature of reality. Epistemologically, contextualists are pragmatists. Regardless of triviality, knowledge and truth are whatever achieves an analytic aim. Describing the ontology and epistemology of contextualism, Pepper (1942) provides this example: “The quality of blowing your nose is just as cosmic and ultimate as Newton's writing down his gravitational formula. The fact that his formula is much more useful to many more people doesn't make it any more real” (p. 251). While Newton’s discovery is not more truthful or “real,” the consequences of his discoveries have a more significant impact. While extreme, Pepper’s example illustrates the degree to which contextualism follows a pragmatic epistemology and distances itself from ontological debates. In sum, contextualists know what they know because it works in achieving their aim, and they do not care if it corresponds to a universal reality.

While contextualism is broad and can encompass several modern paradigms (Fox, 2006), functional contextualism adopts the contextualist worldview but specifies analytic aims of prediction and influence (Biglan & Hayes, 1996; Hayes et al., 1988). While many research design approaches can contribute to the goals of functional contextualism, the gold standard is a scientific inquiry that predicts events and infers causality between a variable and desired outcome. In educational contexts, we may think of this as a learning intervention. For example, in this study, I want to investigate if a variable—self-reference—in a learning activity influences

an outcome—learning transfer. Speaking broadly, Hayes, Barnes-Holmes, et al. (2012) frame the aims of functional contextualism this way:

As a functional contextualist sees it, the ultimate purpose of behavioral science is to change the world in a positive and intentional way. Science is taken to be an empirical strategy of interacting in and with the world so as to learn how to be more effective in organizing it, speaking about it, measuring it, and changing it” (p. 2)

While rooted in behavior-analytic principles, functional contextualism is a pragmatic approach.

In practice, this means studies often employ tools and methods from other paradigms. For example, it is not uncommon for functional contextualists to use self-report measures, inventories, and even qualitative tools (Hayes, Barnes-Holmes, et al., 2012). Embracing a pragmatic approach, this study uses cognitive science tools to predict and influence learning.

Following the principles of functional contextualism, relational frame theory (RFT) seeks to explain verbal behavior and higher-order cognition. Using the theory’s technical terminology, RFT proposes “relational frames” as a new class of operant behavior. Operant behavior is when the frequency of action is controlled by a set of consequences, such as positive or negative reinforcement (Pierce & Cheney, 2008; Skinner, 1976). Relational frames are arbitrarily applicable relational responses under the contextual control of mutual entailment, combinatorial entailment, and the transformation of stimulus functions. Distinct from other operant classes, relations can be derived rather than trained and are not beholden to the nonarbitrary characteristics of the stimuli or relation. Proponents of functional contextualism view RFT as a more robust approach to verbal behavior than traditional behavior analysis (Hayes et al., 2001).

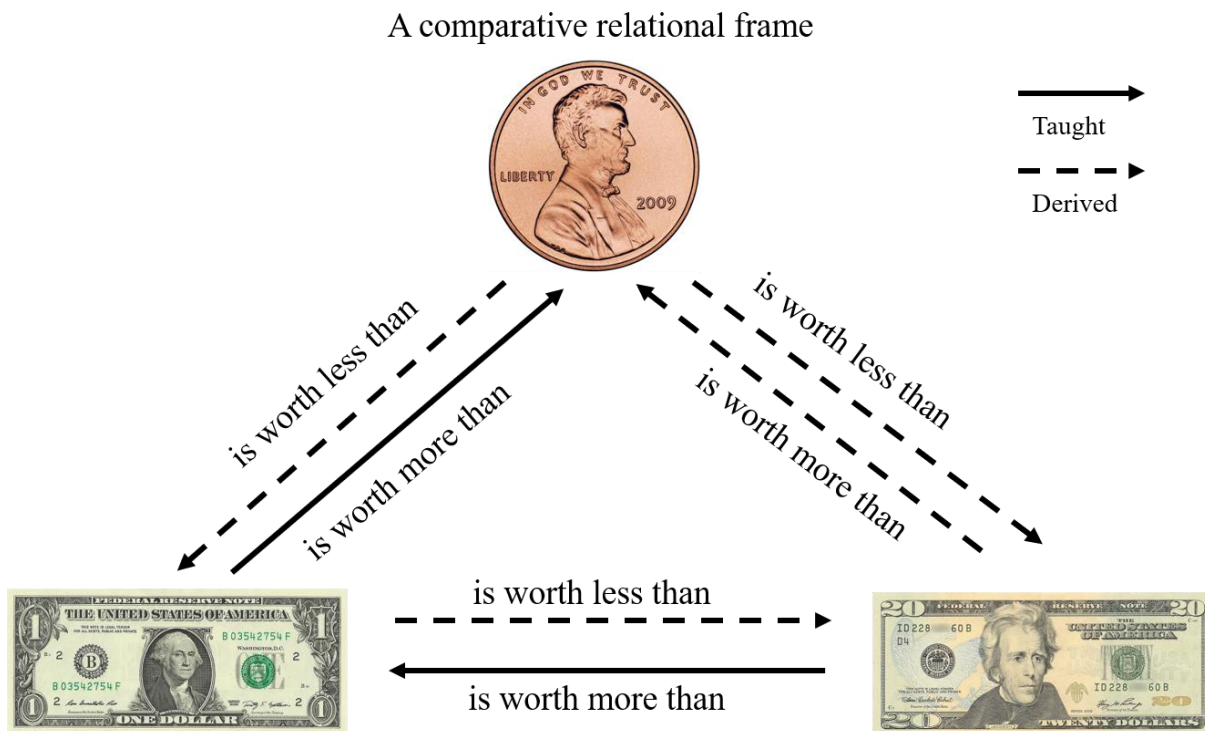
In ordinary language, RFT explains higher-order cognition through verbal development. A person learns by direct instruction of verbal concepts but also by inferring relationships from those concepts. The relationship between taught concepts and inferred concepts is the basis of a relational frame in RFT. Additionally, relational frames can relate to other relational frames *ad*

*infinitum* that form a historical body of unique knowledge. In this way, it is similar to constructivism (see Fox, 2006). A person constructs knowledge from their environment, and they find meaning through relating concepts. Relational frames are not static but change with context. The functional nature of relational frames has significant implications for human learning and development. The components of relational frames are mutual entailment, combinatorial entailment, and the transformation of stimulus functions.

Mutual entailment is a single relationship joining one verbal concept to another. For example, let us say a person is taught “a dollar is worth more than a penny.” In this example, the relationship between the concepts “dollar” and “penny” is called a comparative relationship. Several relationships can be applied other than comparative, such as coordination, temporal, hierarchical, and, as discussed previously, perspective-taking (often called deictic relationships). For example, the sentence “a dollar is one hundred pennies” is a coordinating relationship, while “a dollar is a type of money” is a hierarchical relationship. However, the properties of mutual entailment are not limited by taught behavior. Rather, in the process of human development, people intrinsically learn to make inferences based on the nature of these relationships. For example, if a person is taught “a dollar is worth more than a penny,” they can infer that “a penny is worth less than a dollar.” If the same person is taught “a dollar is one hundred pennies,” they will infer that “one hundred pennies is a dollar.” Inferred, or derived, relationships are the bedrock of RFT.

Combinatorial entailment combines two or more mutually entailed relationships. Using the same example, a person taught “a dollar is worth more than a penny” infers that “a penny is worth less than a dollar.” Additionally, the same person is taught “a twenty-dollar bill is worth more than a dollar” and infers that “a dollar is worth less than a twenty-dollar bill.” On their

own, these statements are distinct mutually entailed relationships. However, the relationships themselves are also related by combinatorial entailment. If the person taught these relationships could deduce that a twenty-dollar bill is worth more than a dollar and a dollar is worth more than a penny, they could likely infer that a twenty-dollar bill is worth more than a penny. They also make additional inferences from these relationships. They infer that a dollar is worth less than a twenty-dollar bill, and a penny is worth less than a dollar. Moreover, the person forms a novel relationship that has not been directly taught: a twenty-dollar bill is worth more than a penny, and a penny is worth less than a twenty-dollar bill.



*Figure 2.* An illustration demonstrating combinatorial entailment. This figure forms relationships between U.S. currency by value.

In explaining combinatorial entailment, I am using concrete examples. Nevertheless, the same principles apply regardless of form, making them arbitrarily derived relationships. If “twenty-dollar bill” is replaced by Z, “dollar” is replaced by X, and “penny” is replaced by Y, and we

repeat the previous example, the person would make the same relationship. Z is more than X, and X is more than Y. Therefore, deducing that Y is less than Z, and Z is more than Y. This arbitrarily derived relationship is an essential principle of RFT, which sets it apart from other behavior-analytic theories of operant behavior.

Mutual and combinatorial entailment make up a logical base of learned behavior. However, it is important to note that these relationships are not exercises in logic but how a person perceives the world. Through experience, a person may think “puppies are a dangerous threat.” In RFT terminology, they developed a relationship between their network of relational frames called “puppies” and their network called “dangerous threat.” Furthermore, that person likely relates affective behaviors to “dangerous threats,” such as fear and anxiety. Therefore, they relate feelings of fear and anxiety to puppies. Many would find a fear of puppies laughable. But, perhaps in that person’s historical context, they were told stories of violent puppy attacks and have since avoided them. As mentioned earlier, historical events and context are crucial to a person’s behavior. In RFT, relationships formed in mutual and combinatorial entailment are under contextual control and, therefore, operate as a function of a stimulus, or a cause of a particular behavior. This component of RFT is called the “transformation of stimulus functions.”

The transformation of stimulus functions suggests relational frames are subject to change and will elicit a different response based on context. Returning to the money example, let us say we ask a person, “Which is more? One dollar or five pennies?” Most older children, adolescents, and adults will answer “one dollar.” With knowledge of currency, people are likely under the contextual control of the functions of “value” and “worth.” They will likely relate the word “more” to “value.” However, a small child may respond with “five pennies;” they do not have a history of learning the concept of currency and value. Instead, the child is under the contextual



control of the function of numeracy—five is more than one. I use money as an example because it naturally demonstrates the arbitrariness of relations in RFT. Different stimulus functions such as value or numeracy can change the meaning and response of a relation. For those unfamiliar with the function of value, “more” is likely to be interpreted as a structural property. Five is more than one. However, those who have a learned history of the concept of value will see “a dollar is more than five pennies.” The concept of money and value is a social construct, making it distinctly human (Hayes, Barnes-Holmes, et al., 2012; Hayes et al., 2001).

Although I have focused on a relational frame as a sole unit, this is never the case in practice. As demonstrated by the previous examples, relational frames relate to other relational frames, ultimately forming a contextual web of knowledge. We assumed people had prior relational frames built on the structural properties of numeracy or the social construct of value. Not only is a single relational frame under contextual control, but functional changes in one frame affect other frames. Let us examine a broader case relevant to adult learning.

Richard, a twenty-seven-year-old man, was recently laid off from his factory job—one he held since graduating high school. Two years before he lost his job, a recruiter from the local community college contacted him about enrolling. At the time, Richard dismissed the idea of going back to school despite his interest in the welding program. He was a mediocre student in high school, and his teachers and peers often contributed to his self-perception as “someone who isn’t good at school.” However, he is now unemployed, and his circumstances have changed. His husband Gary, a person Richard loves and trusts, has been persuading Richard for weeks that he can learn new skills, even in a formal environment. Finally, with Gary’s encouragement and facing unemployment, Richard acquiesces and enrolls in the welding program. This case has a

lot of history and context to unravel, some of which we do not know. However, I want to focus on the general premise of this story in terms of functional change.

Two years before his unemployment, Richard was confronted with the prospect of attending community college. However, somewhere in his contextual history, he related “someone who isn’t good at school” to his sense of self. This thought was reinforced by his teachers and peers, causing a stronger relationship between the two. He relates community college with school and, in turn, relates school with aversion. This network of relational frames caused Richard to respond by dismissing the prospect of attending community college, despite his interest in the welding program. Two years later, however, Richard’s context changes. He is now unemployed and focused on the immediate future. Additionally, Gary has been persuading Richard to reconsider the welding program and influences Richard’s perception of his ability. From an RFT perspective, we can speculate that Gary’s persuasion diminished the relationship between Richard’s sense of self and “someone who isn’t good at school.” Moreover, the functional change of Richard’s relationship between “sense of self” and “employed” likely set in motion a series of functional changes between other, interconnected relational frames. These functional changes influenced his decision to enroll in the welding program. While this scenario oversimplifies the complexities of RFT, it emphasizes the roles of relational responding and functional control on human behavior. RFT is a relatively new theory that is still evolving (Dymond & Roche, 2013), and I hope I explained it coherently without losing too much precision. For a more comprehensive account, see Hayes et al. (2001), Dymond & Roche (2013), and Törneke (2010). Now, I turn to relational frame theory’s application to this study.

Relational frame theory is a good fit as a framework for teaching concept maps. While traditional Novakian concept mapping uses propositional language as linking words (Novak &

Gowin, 1984), relational frame theory-based concept mapping links concepts as relational frames (Roessger et al., 2018). As this graphical representation of relational frames continues to build, the possibility to make meaning increases when learners use cross-links to connect relational frames that, at first, may seem unrelated. Furthermore, as teaching concept mapping with relational frames has been shown to influence relational scores (Roessger et al., 2018), and relational reasoning is argued to underly transfer (Haskell, 2001), it follows that teaching concept mapping through relational framing on its own should influence transfer.

While the transfer of learning is studied much more extensively in cognitive psychology, this phenomenon can be explained through RFT as a learner relating an antecedent network of relational frames to new concepts. The degree of transfer depends on how similar the new concepts are to concepts in the person's relational repertoire. With this perspective, RFT considers near and far transfer as contextual proximity to the original learning environment. I am examining the influence of concept mapping in the middle of the transfer spectrum in this case. The classroom environment is the same, but I use different activities to determine if concept mapping influences learning transfer. Furthermore, the cognitive psychology literature suggests that relating concepts to the self is a superior mnemonic device. RFT conceptualizes traits and events related to the self as strongly reinforced behaviors under contextual control (D. Barnes-Holmes et al., 2001). While the concept of the self is theoretically different in cognitive psychology, self-reference is operationalized and measured the same. Therefore, self-reference should further influence learning transfer by relating a learner's historical repertoire—their experiences and conceptualized self—to novel relationships. Likewise, while sense of self and reflection are theoretically different in RFT, tools developed from cognitive psychology operationalize and measure the same construct.

## Research Questions and Hypotheses

1. After repeated practice and feedback, does concept mapping affect the transfer of learning?
  - a. After controlling for concept map structural scores, age, sense of self, reflective aptitude, and relational ability, transfer of learning will improve after learners receive feedback on consecutive concept maps.
2. After repeated practice and feedback, does self-reference in concept maps affect transfer of learning?
  - a. After controlling for concept map structural scores, age, sense of self, reflective aptitude, and relational ability, learners' transfer scores will immediately increase when referencing themselves in concept maps.
  - b. After controlling for concept map structural scores, age, sense of self, reflective aptitude, and relational ability, learners' transfer scores will grow over time when referencing themselves in concept maps.
3. Is there an interaction between self-reference in concept maps and a learner's age on the growth of learning transfer?
  - a. Older learners will have greater transfer of learning growth rates than younger learners after the self-reference intervention.
4. Is there an interaction between self-reference in concept maps and a learner's reflective aptitude on the growth of learning transfer?
  - a. The higher a learner's reflective aptitude, the more self-reference will contribute to the growth of transfer of learning.

5. Is there an interaction effect between self-reference in concept maps and sense of self on the growth of learning transfer?
  - a. The higher a learner's sense of self, the more self-reference will contribute to the growth of learning transfer.
6. Is there an interaction effect between self-reference in concept maps and a learner's relational ability on the growth of learning transfer?
  - a. The higher a learner's relational ability, the more self-reference will contribute to the growth of learning transfer.

## **Summary**

In this chapter, I examined the historical, conceptual, and empirical literature of concept maps, the self-reference effect, and learner transfer, as well as the potential moderating effects of sense of self, reflective aptitude, and relational ability. I discussed and summarized the literature and explored how these variables relate to relational frame theory. The efficacy of concept maps, the self-reference effect, and learning transfer as separate entities are well documented in the literature. Theoretical and empirical evidence suggests that learners can transfer skills learned in concept maps to other activities, especially if concept maps are modeled, practiced, and learners are given feedback. Additionally, the literature suggests self-reference on its own influences transfer. Combined with a concept map activity, self-reference may provide more relevance and value for the learner. Furthermore, sense of self and reflective ability likely moderate the self-reference effect, as the ability to reflect on one's self and have a stable identity should influence how a learner associates themselves with various concepts. The theoretical literature suggests relational ability will moderate RFT-based concept map construction, and empirical literature

suggests it could mediate transfer as a cognitive ability. Chapter 3 discusses the research design and how these concepts are operationalized, measured, and analyzed.

## Chapter 3 – Methodology

### Introduction

In this chapter, I state the research questions and hypotheses and discuss the study's methods. Within the methods section, I describe the study's overall design, participants, context, and materials. Additionally, I conceptually and operationally define each item measured and describe how the data will be collected and analyzed. Finally, I discuss potential threats to internal and external validity that may affect the study.

### Research Questions and Hypotheses

- 1) After repeated practice and feedback, does concept mapping affect the transfer of learning?
  - a. **Hypothesis:** After controlling for concept map structural scores, age, sense of self, reflective aptitude, and relational ability, transfer of learning will improve after learners receive feedback on consecutive concept maps.
  - b. **Statistical hypothesis:**  $H_0: \beta_1 Time = 0; H_1: \beta_1 Time > 0$
  - c. **Model:**  $\ln \hat{Y}_i = \alpha + \hat{\beta}_1 Time_i + \hat{\beta}_2 Scores_i + \hat{\beta}_3 Age_i + \hat{\beta}_4 SOS_i + \hat{\beta}_5 RefA_i + \hat{\beta}_6 RelA_i + s_i \log(conceptsTotal) + \epsilon_i$
- 2) After repeated practice and feedback, does self-reference in concept maps affect transfer of learning?
  - a. **Hypothesis A:** After controlling for concept map structural scores, age, sense of self, reflective aptitude, and relational ability, learners' transfer scores will immediately increase when referencing themselves in concept maps.
    - i. **Statistical hypothesis:**

$$H_0: \beta_7 Treatment = 0;$$

$$H_1: \beta_7 Treatment > 0$$

$$ii. \ln \hat{Y}_i = \alpha + \hat{\beta}_1 Time_i + \hat{\beta}_2 Scores_i + \hat{\beta}_3 Age_i + \hat{\beta}_4 SOS_i + \hat{\beta}_5 RefA_i + \hat{\beta}_6 RelA_i + \hat{\beta}_7 Treatment_i + s_i \log(conceptsTotal) + \epsilon_i$$

- b. **Hypothesis B:** After controlling for concept map structural scores, age, sense of self, reflective aptitude, and relational ability, learners' transfer scores will grow over time when referencing themselves in concept maps.

- i. **Statistical hypothesis:**

$$H_0: \beta_8 Treatment * Time = 0;$$

$$H_1: \beta_8 Treatment * Time > 0$$

$$ii. \text{ **Model:}** } \ln \hat{Y}_i = \alpha + \hat{\beta}_1 Time_i + \hat{\beta}_2 Scores_i + \hat{\beta}_3 Age_i + \hat{\beta}_4 SOS_i + \hat{\beta}_5 RefA_i + \hat{\beta}_6 RelA_i + \hat{\beta}_7 Treatment_i + \hat{\beta}_8 Time_i * Treatment_i + s_i \log(conceptsTotal) + \epsilon_i$$

- 3) Is there an interaction between self-reference in concept maps and a learner's age on the growth of learning transfer?

- a. **Hypothesis:** Older learners will have greater transfer of learning growth rates than younger learners after the self-reference intervention.

- b. **Statistical hypothesis:**

$$H_0: \beta_9 (Treatment * Time) * Age = 0;$$

$$H_1: \beta_9 (Treatment * Time) * Age > 0$$

$$c. \text{ **Model:}** } \ln \hat{Y}_i = \alpha + \hat{\beta}_1 Time_i + \hat{\beta}_2 Scores_i + \hat{\beta}_3 Age_i + \hat{\beta}_4 SOS_i + \hat{\beta}_5 RefA_i + \hat{\beta}_6 RelA_i + \hat{\beta}_7 Treatment_i + \hat{\beta}_8 Time_i * Treatment_i + \hat{\beta}_9 (Time_i * Treatment_i) * Age_i + s_i \log(conceptsTotal) + \epsilon_i$$



4) Is there an interaction between self-reference in concept maps and a learner's reflective aptitude on the growth of learning transfer?

a. **Hypothesis:** The higher a learner's reflective aptitude, the more self-reference will contribute to the growth of transfer of learning.

b. **Statistical hypothesis:**

$$H_0: \beta_9(Treatment * Time) * RefA = 0;$$

$$H_1: \beta_9(Treatment * Time) * RefA > 0$$

c. **Model:**  $\ln \hat{Y}_i = \alpha + \hat{\beta}_1 Time_i + \hat{\beta}_2 Scores_i + \hat{\beta}_3 Age_i + \hat{\beta}_4 SOS_i + \hat{\beta}_5 RefA_i + \hat{\beta}_6 RelA_i + \hat{\beta}_7 Treatment_i + \hat{\beta}_8 Time_i * Treatment_i + \hat{\beta}_9 (Time_i * Treatment_i) * RefA_i + s_i \log(conceptsTotal) + \epsilon_i$

5) Is there an interaction effect between self-reference in concept maps and sense of self on the growth of learning transfer?

a. **Hypothesis:** The higher a learner's sense of self, the more self-reference will contribute to the growth of learning transfer.

b. **Statistical hypothesis:**

$$H_0: \beta_9(Treatment * Time) * SoS = 0;$$

$$H_1: \beta_9(Treatment * Time) * SoS > 0$$

c. **Model:**  $\ln \hat{Y}_i = \alpha + \hat{\beta}_1 Time_i + \hat{\beta}_2 Scores_i + \hat{\beta}_3 Age_i + \hat{\beta}_4 SOS_i + \hat{\beta}_5 RefA_i + \hat{\beta}_6 RelA_i + \hat{\beta}_7 Treatment_i + \hat{\beta}_8 Time_i * Treatment_i + \hat{\beta}_9 (Time_i * Treatment_i) * SoS_i + s_i \log(conceptsTotal) + \epsilon_i$

6) Is there an interaction effect between self-reference in concept maps and a learner's relational ability on the growth of learning transfer?

- a. **Hypothesis:** The higher a learner's relational ability, the more self-reference will contribute to the growth of learning transfer.

- b. **Statistical hypothesis:**

$$H_0: \beta_9(Treatment * Time) * RelA = 0;$$

$$H_1: \beta_9(Treatment * Time) * RelA > 0$$

- c. **Model:**  $\ln \hat{Y}_i = \alpha + \hat{\beta}_1 Time_{ij} + \hat{\beta}_2 Scores_i + \hat{\beta}_3 Age_i + \hat{\beta}_4 SOS_i + \hat{\beta}_5 RefA_i + \hat{\beta}_6 RelA_i + \hat{\beta}_7 Treatment_i + \hat{\beta}_8 Time_i * Treatment_i + \hat{\beta}_9 (Time_i * Treatment_i) * RelA_i + s_i \log(conceptsTotal) + \epsilon_i$

## Methods

### *Study Design*

I used a segmented repeated-measures design to test the above hypotheses. The unit of analysis is transfer scores of participants over eight equidistant measures of time. Over 16 weeks, learners created eight concept maps and completed eight transfer assignments, alternating assignments every week. Repeated measures account for growth in learners' creation and understanding of concept maps. Roessger et al.'s (2018) study suggests this happens after repeated practice and feedback. I administered a self-reference treatment—a change in instruction—at time point five to determine if there is a self-reference effect.

Considering authenticity, I conducted the study in a graduate-level adult learning theory class. The class is a program requirement for the Adult & Lifelong Learning master's program, although one participant enrolled in the course as an elective. Participants received standardized feedback and instruction on constructing concept maps throughout the course, similar to Roessger et al. (2018; see Appendix A). One week after receiving feedback on a concept map, each student completed a written assignment between 500 and 1000 words requiring them to

relate the concept map topic to a real-world problem. To measure transfer, I calculated a score by counting the number of concepts used in the transfer assignment present in the concept map.

$$S_{ti} = \sum Concept_{ati} \mid Concept_{ati} \in Map_{ti}$$

Where  $S_{ti}$  is the transfer score for student  $i$  at time  $t$ ,  $Concept_{ati}$  is the concept  $a$  for student  $i$  at time  $t$ , and  $Map_{ti}$  is the map of student  $i$  at time  $t$ .

The concept map and transfer assignment covered a different topic relevant to adult learning for each measure. I gathered preliminary data on a student's age, sense of self, reflective aptitude, and relational ability during the first week (see Figure 3 for the sequence of tasks). Before the intervention, I provided video instruction and a demonstration on constructing concept maps. Instruction includes:

- Using the CmapTools software
- An introduction to relational frames (see Roessger et al., 2018)
- Constructing maps by creating concepts, properly linking concepts, the elements of a proposition, differentiating concepts, and linking concepts across maps
- Using relational frames in concept maps

Throughout the study, I repeatedly gave students feedback on the construction of concept maps. For the treatment, I used an additional instructional video demonstrating self-reference in concept maps, elaborating on personal traits and experiences. After the treatment, I provided specific feedback to incorporate self-reference in concept maps (see Appendix A).

Controlling for historical effects bias, participants also completed an additional assignment the same week they completed concept map assignments. Historical effects bias—or history bias—is when an event outside of the experiment affects the outcome. For example, when I implemented the treatment—self-reference—participants coincidentally might have

learned a technique for achieving transfer from another source outside of the classroom. Shadish et al. (2002) suggest using a non-equivalent outcome in the experiment to control for this bias. Therefore, participants completed two additional assignments: an outline and a written assignment over the outline topic. Since there is no theoretical claim or empirical support that outlining influences learning transfer, participants completed the outline assignment in the same week as the concept map and completed the written assessment one week after receiving feedback on the outline assignment. The written assessment for the outline acts as the non-equivalent outcome, controlling for historical effects bias.

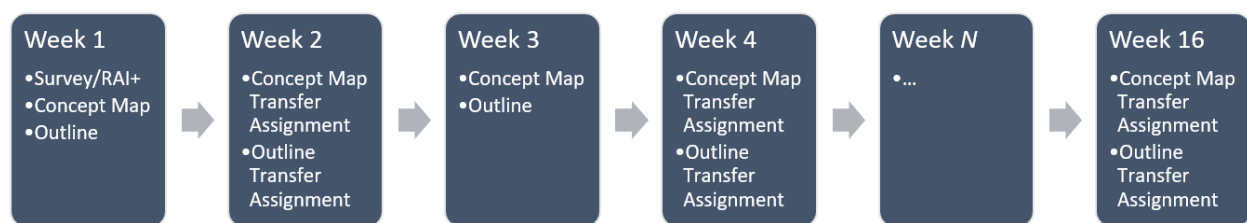


Figure 3. Sequence of tasks.

### ***Study Setting***

I conducted the study in a large, public, higher education institution in Arkansas. Participants are adult learners in an adult education graduate course, with one instructor in one classroom. While a non-experimental design has limitations, it provides ecological validity and broader generalization to the studied demographic.

### ***Participants and Placement***

Participants in this study are graduate students in an adult education program. Most participants reside in the southern United States. While age varies, many are considered non-traditional students, ranging from 25-65+ years old. Previous literature on the self-reference

effect suggests a medium effect size (Symons & Johnson, 1997) for the intervention and a medium growth rate (Roessger et al., 2018). Considering these studies, I conducted a simulation to determine power with various sample sizes assuming a medium treatment over time effect (Parker, 2021a).

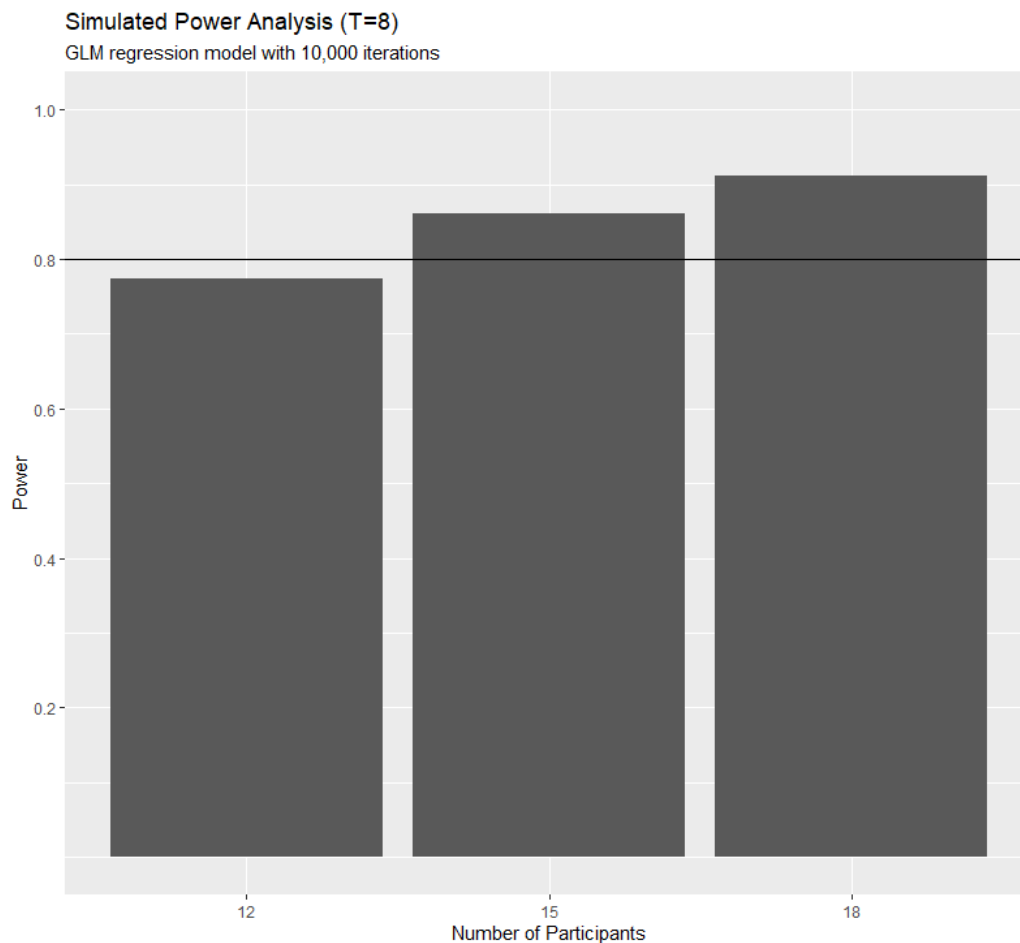


Figure 4. Simulated power analysis for the study.

The simulation ran a randomized generalized linear model 10,000 times each for possible sample sizes 12, 15, and 18. Each iteration tested the significance of the time by treatment interaction at  $\alpha = .05$ . Assuming a medium growth effect for the intervention—based on the parameter estimates from Roessger et al. (2018)—the simulation estimates the study would have power of  $1 - \beta = .86$  for eight measures for 15 participants. Or, said differently, the chances of

finding a medium effect where one exists is 86%. Typically, a study is considered sufficiently powered at  $1 - \beta = .8$  (Creswell & Creswell, 2018). For 12 participants, the simulation estimates a power estimate at  $1 - \beta = .77$ , nearly approaching the .8 threshold. After the study, I had data for 13 participants. After re-examining the power curve, I confirmed the study was sufficiently powered at  $1 - \beta = .81$ .

### ***Materials***

Each participant completed an online questionnaire that asks for the participant's age and contains the self-reflection section of Grant et al.'s (2002) Self-Reflection and Insight Scale (SRIS) and Flury's (2004) Sense of Self Scale (SOSS). Additionally, participants completed the Relational Abilities Index+ (RAI+). Cassidy et al. (2011) developed the RAI+ to test a person's ability to form relations within the context of relational frame theory. Researchers have successfully validated the index with multiple cognitive ability tests (Cassidy et al., 2016; Colbert et al., 2017, 2019). The SOSS was developed to study Borderline Personality Disorder, but it has been used to assess sense of self as it relates to the self-reference effect (Roessger et al., 2021), and its validity and reliability to assess the sense of self construct are documented in the literature (Flury, 2004; Flury & Ickes, 2007). The SRIS was developed within cognitive psychology to assess components of the Psychological Mindedness construct. While the lack of functional definitions of reflection in the adult education literature makes operationalization difficult (Roessger, 2017), the SRIS is a validated instrument suited for a pragmatic study (Grant et al., 2002). In addition to the above instruments, participants used CMapTools software, developed by the Florida Institute of Human and Machine Cognition, to create concept maps. The software allows participants to rapidly construct concept maps in a user-friendly

environment. I provided instructions and a demonstration for participants on how to use the software.

### ***Measures***

**Transfer.** Transfer is the dependent variable in this study. Transfer is defined conceptually as “effective and continuing application by learners—to their performance of jobs or other individual, organizational, or community responsibilities—of knowledge and skills gained in learning activities (Broad, 1997, p. 2)”. That is, transfer is the ability to apply learned content from one context to another. There are various types of transfer discussed in the literature, such as near and far, high road and low road, and positive and negative. In the adult education literature, concept mapping has been suggested as a learning tool to facilitate transfer (Foley & Kaiser, 2013). In this study, I operationally define transfer as the number of concepts used in the transfer assignment present in the concept map.

$$S_{ti} = \sum Concept_{ati} \mid Concept_{ati} \in Map_{ti}$$

Where  $S_{ti}$  is the transfer score for student  $i$  at time  $t$ ,  $Concept_{ati}$  is the concept  $a$  for student  $i$  at time  $t$ , and  $Map_{ti}$  is the map of student  $i$  at time  $t$ . Additionally, I introduce the total number of concepts in the preceding concept map as an offset variable in the model.

**The self-reference effect.** Self-reference is one of two interventions and the variable of interest in this study. Symons and Johnson (1997) conceptually define the self-reference effect as the phenomenon of mnemonic superiority from relating material to the self. Departing from traditional methods of teaching concept mapping, some educators have implemented self-reference as an enhancement, combining elaboration of autobiographical memory and the self with semantic elaboration inherent in concept maps. I operationalize self-reference in the study by changing instruction and feedback in the concept mapping assignments. Initially, participants

receive direction and feedback on traditional methods of concept mapping (Novak & Cañas, 2008). After the fourth measure, participants receive the treatment—a change in instruction emphasizing self-reference in concept maps.

**Concept maps (repeated measure).** Concept maps act as the other intervention in this study. Concept maps are conceptually defined as “graphical tools for organizing and representing knowledge” (Novak & Cañas, 2008, para. 1). When used as a learning strategy, concept maps have a significant body of research (Nesbit & Adesope, 2006; Schroeder et al., 2018). In this study, participants constructed concept maps using the CMapTools software. This software facilitates the construction of concept maps into concepts, propositions, hierarchies, and cross-links, allowing for analysis of structural scores and the collection of concepts.

**Concept map scores (structural).** Concept map scores are a control variable in this study. In assessing concept maps, researchers have used several scoring models (Anohina & Grundspenkis, 2009). Scoring is often broken into three separate categories: structural, relational, and mixed. Jablokow et al. (2013) found similar validity among both structural and relational scoring procedures. Following the precedence of a similar study (Roessger et al., 2018), I used the structural scoring method defined by West et al. (2002). I calculated the structural score with assistance from the *cxlAnalyze* package in R (Parker, 2021b).

**Learner’s age.** The adult education literature theorizes that age contributes to variance in learning characteristics (Knowles et al., 2015). It follows, then, that as learners accumulate more life experience, there will be more opportunities to draw from autobiographical memory. Age is operationalized as a continuous variable: the number of years a learner has lived.

**Reflective aptitude.** The self-reference effect suggests learners will better remember memories and traits associated with their conceptualized self; therefore, a learner's aptitude to



reflect on one's self is a potential moderating variable. Reflective aptitude is the ability to engage in metacognitive thinking that allows understanding of a person's emotions and behavior (Grant, 2001). It is operationalized using scores from the self-reflection subscale of the Self-Reflection and Insight Scale (SRIS; SRIS-SR).

**Sense of self.** Sense of self is also a potential moderating variable. Flury and Ickes (2007) define sense of self as ranging on a continuum from individuals possessing a weak sense of self to a strong sense of self. The authors claim people with a weak sense of self feel “as if they do not know who they are, what they think, what their own opinions are, or what religion they should adopt” (p. 281). This study operationalizes sense of self using scores from the Sense of Self Scale (SOSS).

**Relational ability.** Relational ability theoretically moderates a learner's capability to construct RFT-based concept maps. Additionally, with its association to cognitive capability, it may moderate transfer scores. Relational ability is a person's ability to form relationships between concepts. For relational frame theorists, they perceive it as a skill and measure of cognitive ability (Cassidy et al., 2011, 2016). It is operationalized using scores from the Relational Abilities Index+ assessment (Colbert et al., 2019).

## **Data Collection**

During the first week of class, participants received an electronic survey that asked for the participant's age and included the combined Sense of Self Scale and Self-Reflection and Insight Scale-SR subset. Participants also completed the Relational Abilities Index+ (RAI+) online through a link provided by the researcher. Every two weeks throughout the 16-week semester, I collected participant concept map images, CXL files, and transfer assessments. Participants submitted these files through the Blackboard learning management system. Within a

16-week course term, participants created eight concept maps. One week after each concept map, participants completed a written assignment to assess transfer. Participants also submitted the outline assignment the same day as the concept map assignment. Like the concept map assignment, participants completed a written assignment one week after the outline. This written assignment acted to mitigate historical effects bias. I summarized survey results appropriate to each operational definition of the construct. Additionally, I summarized concept map scores according to the structural scoring formula from West et al. (2002) and transfer scores as the number of concepts used in the written assignment present in the prior concept map.

### **Data Analysis**

For repeated measures designs, researchers typically select Repeated Measures ANOVA or ANCOVA, linear or non-linear mixed-effects models, or generalized estimating equations (GEE) (Ballinger, 2004). As the dependent variable is count data, I used a negative binomial distribution to account for skew. I could not use RM ANCOVA or a linear mixed-effects models without biased estimates with a log-linear dependent variable. Therefore, my modeling options were to use either a generalized linear mixed-effects model (GLMM) or GEE. Researchers who have compared GLMM and GEE models for longitudinal studies suggest that GEE provides the most efficient estimates for studies that focus on population averages (Ballinger, 2004; Gardiner et al., 2009; Hanley et al., 2003; Hubbard et al., 2010). For this study, I focus on generalizing findings to the adult learner population rather than the variation between individual clusters of adult learners. Additionally, while the literature suggests GEE is most appropriate for studies with twenty or more participants (or clusters), Muth et al. (2016) argue that GEE is still the most precise estimator for small, longitudinal studies rather than mixed-effects models. Therefore, I used GEE to test the study's hypotheses.

I used the R statistical software package (R Core Team, 2019) to compile and analyze the data; however, the GEE procedure was conducted in SPSS Version 26 as current R packages do not have sufficient support for the negative binomial distribution in GEE. Additionally, I used an R package I created, *cxlAnalyze* (Parker, 2021b), to parse components from concept maps and help generate a structural score. I prepared data using the *tidyverse* (Wickham et al., 2019) collection of packages, and I generated tables and charts using the R packages *ggplot2* (Wickham, 2016) and *kableExtra* (Zhu, 2021).

### **Internal and External Validity**

As a non-experimental, repeated measures study, I address a few threats to internal validity. According to the literature, age, feedback, concept map quality, sense of self, reflective aptitude, and relational ability are potential confounds for the study. Therefore, this study accounts for those factors as variables in the model, and I standardize feedback across all participants. As a repeated measures study, external events could occur that would affect the study. For example, when I implemented the treatment—self-reference—participants coincidentally might have learned a technique for achieving transfer in another class before or during the treatment. I mitigate this by adding an outline assignment and transfer assessment. The additional outline assignment has no empirical or theoretical support for influencing transfer. As the study’s design tests learners over time, the testing effect could impact the study; however, I account for this by standardizing feedback and, importantly, assessing each measure over a different topic. Each week's outline and concept map assignment were over different topics, so the outline assignment also acts as mitigation for the testing effect. Finally, as I am fully engaged in the study as an instructor, experimenter bias potentially impacts the study.

One of the advantages of a study conducted in an authentic environment is that it mitigates some common external validity threats. However, there are still threats that may be present. With experimental and many quasi- and non-experimental studies, the Hawthorne effect could potentially affect the study. I used a slight level of deception to prevent participants from behaving inauthentically. I told participants that the study was investigating language use in concept maps and outlines. Additionally, the natural setting of a classroom likely assists in mitigating the Hawthorne effect.

### **Summary**

In this chapter, I discussed the research questions, hypotheses, and methods of the study. I explained the design as a segmented repeated measures study conducted in a university classroom with graduate adult education students as participants. I conceptually and operationally defined the measures in the study, discussed the instruments and software used to collect the data, and the procedures for data collection. I discussed using a negative binomial GEE model to analyze the data. Finally, I examined potential threats to internal and external validity.

## **Chapter 4 – Findings**

The purpose of this study was to examine whether self-reference in concept mapping improves learning transfer. As learning transfer is a sought-after outcome in the adult learning literature (Foley & Kaiser, 2013), these findings are relevant for both researchers and practitioners. In this chapter, I provide an overview of the study's participants while also discussing the measures and tools used for data analysis. I then provide the findings for each hypothesis. I conclude with a summary of the prominent findings.

### **Demographics & Descriptive Statistics**

The study's participants were students enrolled in a master's level foundational course in adult learning at a large state university in the southern United States. Most students were required to take the course as part of their graduate program in adult learning. However, some took the class as an elective. The adult learning master's program is entirely online and targets working adults seeking professional development, career advancement, or state licensure in adult education. Therefore, many participants are considered non-traditional students and are older than the average university student.

A total of 16 students participated in the study. However, three students had considerable missing repeated measures data and were removed from the dataset, while another student had missing inventory data. As this participant had no missing data for the dependent variable, I used the R package *mice*, which uses a multiple imputation method called "multiple imputation by chained equations," to estimate the value for the inventory data (Buuren & Groothuis-Oudshoorn, 2011). Unlike single imputation, which often uses a single mean value as the true value, the multiple imputation process runs several regression models on variables in the dataset, eventually converging with a consistent imputed data point (Azur et al., 2011). After the multiple

imputation process, my data set contained 13 participants over eight repeated measures. The table below provides descriptive statistics for participants' age and inventory scores.

*Table 1. Descriptive Statistics of Participants (N = 13).*

	Age	SRIS-SR	SOSS	RAI
<b>Mean</b>	45.38	56.92	23	45.92
<b>SD</b>	13.85	8.50	6.12	6.13
<b>Median</b>	45	59	22	45
<b>Min</b>	22	40	16	37
<b>Max</b>	69	71	35	54
<b>Z-Skew (bootstrapped)</b>	-0.09	-1.10	1.37	-0.11
<b>Z-Kurtosis (bootstrapped)</b>	-1.74	-0.95	-1.76	-4.61
<b>SE (bootstrapped)</b>	3.42	2.09	1.49	1.51

The mean age of participants was 45 ( $SD = 13.85$ ). The inventory used to measure aptitude for self-reflection was the Self Reflection subscale of Grant's (2002) Self Reflection and Insight Scale (SRIS-SR). On average, participants scored 56.92 ( $SD = 8.5$ ). The scale range is 12-72, with higher scores reflecting stronger engagement and need for self-reflection. I used Flury's (2004) Sense of Self Scale (SOSS) to measure a participants' sense of self. On average, participants scored 23 ( $SD = 6.12$ ). The scale range is 12-48, with higher scores reflecting a stronger sense of self and lower scores reflecting a weaker sense of self. Finally, I used the Relational Abilities Index+ (RAI) to measure relational ability (Cassidy et al., 2016). On average, participants scored 45.92 ( $SD = 6.13$ ). The scale range is 0-55, with higher scores indicating a stronger ability to derive relationships between concepts. I provide frequency graphs of each measure below.

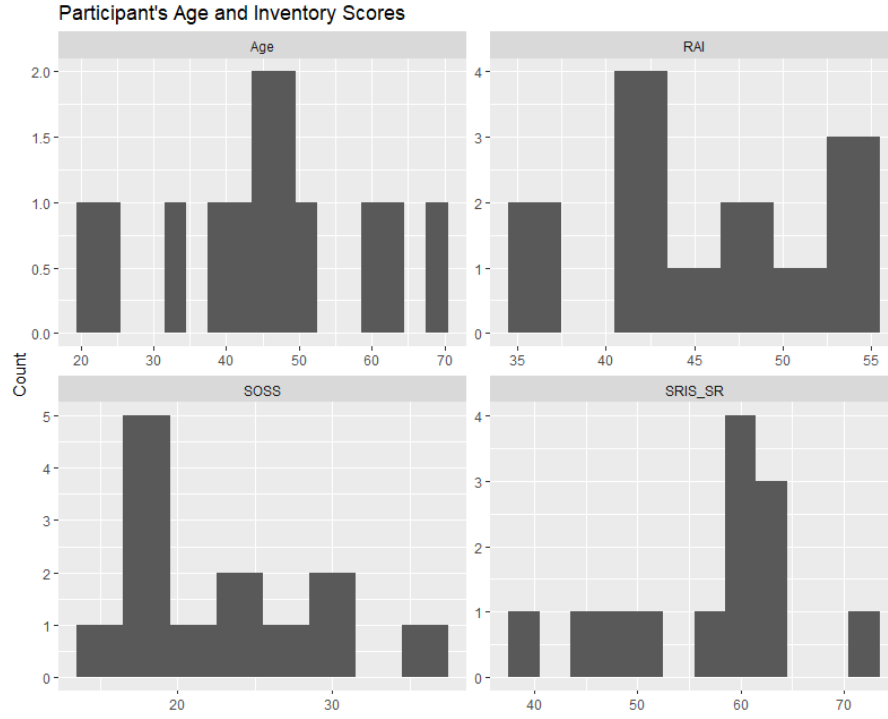


Figure 5. Histogram of Participant Age and Inventory Data.

## Measures & Analysis

The dependent variable is a transfer score, calculated as the sum of concepts in a transfer assignment mentioned in the corresponding concept map.

$$S_{ti} = \sum Concept_{ati} \mid Concept_{ati} \in Map_{ti}$$

Where  $S_{ti}$  is the transfer score for student  $i$  at time  $t$ ,  $Concept_{ati}$  is the concept  $a$  for student  $i$  at time  $t$ , and  $Map_{ti}$  is the map of student  $i$  at time  $t$ . I constructed this score programmatically by writing a script that compared words in the transfer assignment to concepts in the concept map (Parker, 2021a). Additionally, to control for concept map quality, I calculated a structural score using methodology from West et al. (2002). For each concept map, the score is calculated by assigning two points to every link between concepts, five points to every level of hierarchy in the map, and ten points to every cross-map link. The points are then summed to create a total structural score for the map. Finally, I controlled for the influence of external events by assessing

transfer from an outline assignment. I calculated the control transfer score like the concept map transfer score, summing the number of words in a transfer assignment used in an outline bullet point.

$$C_{ti} = \sum Concept_{ati} \mid Concept_{ati} \in Outline_{ti}$$

Where  $C_{ti}$  is the control transfer score for student  $i$  at time  $t$ ,  $Concept_{ati}$  is the concept  $a$  for student  $i$  at time  $t$ , and  $Outline_{ti}$  is the outline of student  $i$  at time  $t$ . Summary statistics for the transfer score, the outline score (acting as a control), and the concept map structural score are listed below.

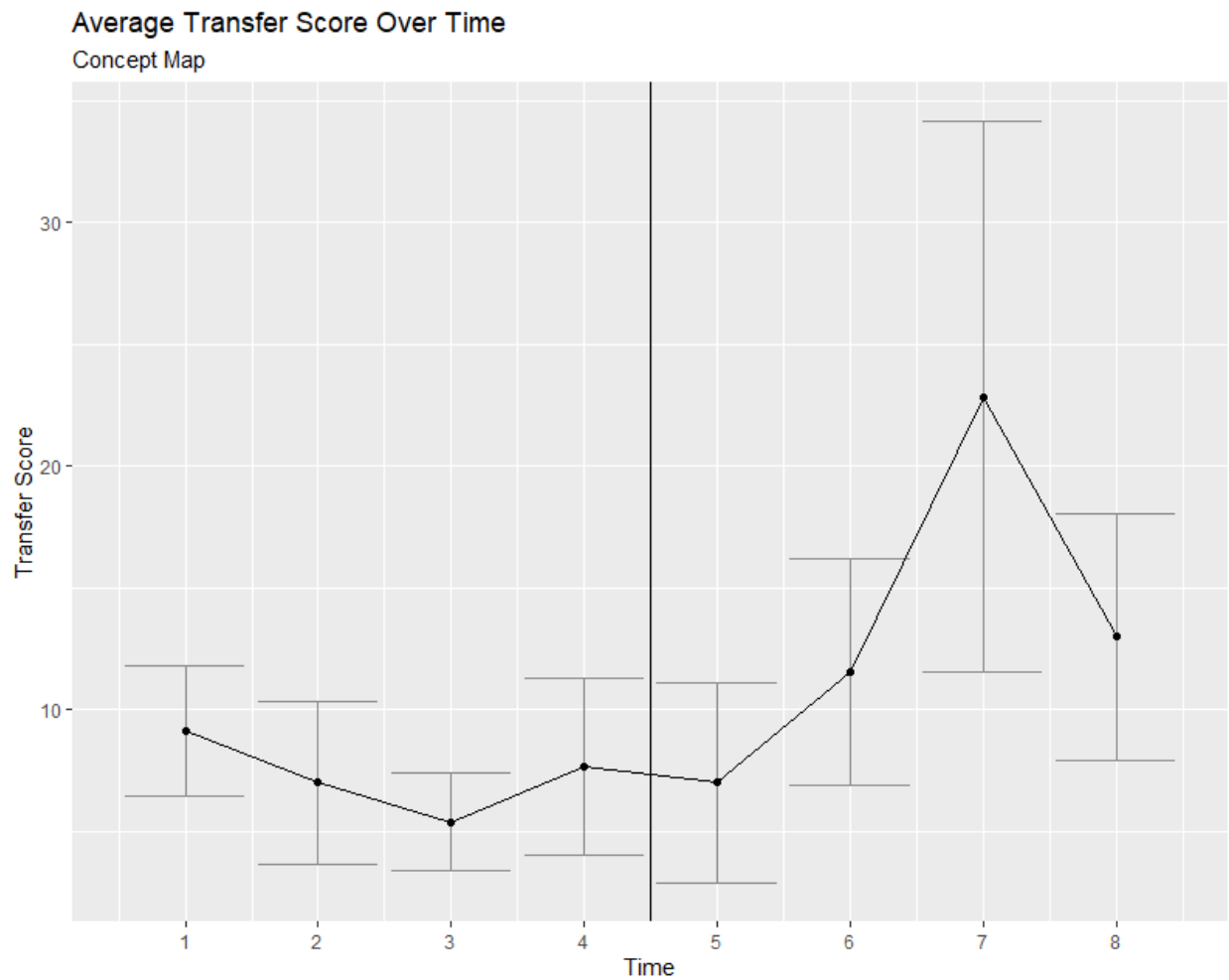
*Table 2.* Descriptive statistics of participant scores across all time points (Obvs = 104).

	CM Structural Score	CM Transfer Score	Outline Transfer Score
Mean	106.06	10.45	98.14
SD	117.07	10.02	91.56
Median	66	8	60
Min	15	0	2
Max	558	60	405
Z-Skew (bootstrapped)	6.67	5.50	6.47
Z-Kurtosis (bootstrapped)	2.13	2.72	1.52
SE (bootstrapped)	11.45	0.97	8.95

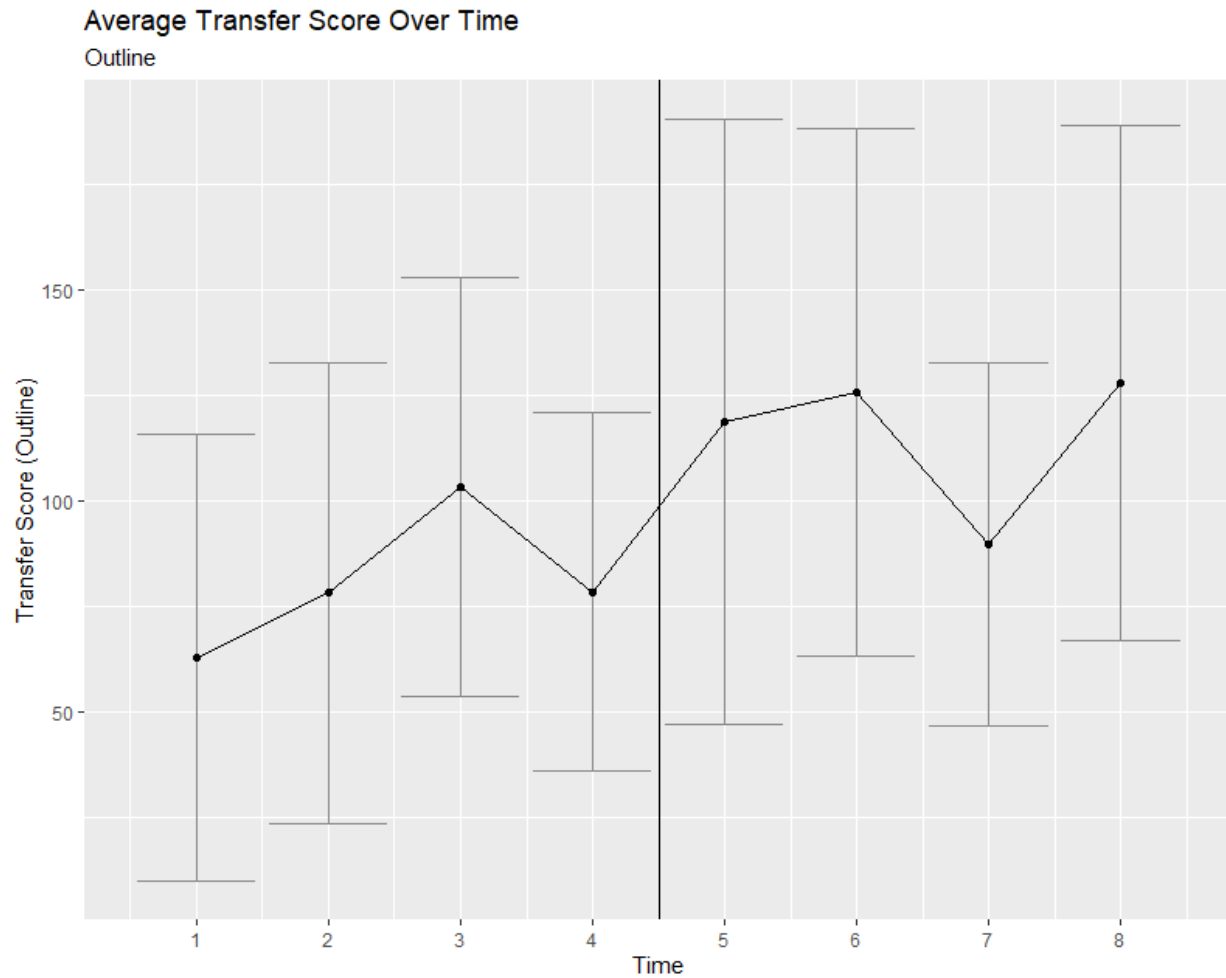
Interestingly, pooled outline transfer scores were higher than pooled concept map transfer scores ( $t = 17.63, p < .001$ ). Participants likely used outlines as a guide to writing the essay, resulting in higher usage of words from the outline. During the study, I noticed some participants, despite instructions and feedback, including essay structure in the outline (e.g., “Introduction,” “Conclusion”). Additionally, I found significant growth in transfer scores across time for the outline assignment ( $\beta = .19, p = .001$ ). However, the introduction of the treatment ( $\beta = -.04, p$



$> .05$ ) and treatment over time ( $\beta = -.08, p > .05$ ) were not significant. These findings suggest that if self-reference affected transfer in concept maps, it was unlikely caused by an event occurring outside of the intervention. Line graphs below show transfer scores over time for the concept map and the outline, with 95% confidence interval error bars and a vertical line representing the time before and after the intervention.



*Figure 6. Average Transfer Score over Time from Concept Mapping.*



*Figure 7.* Average Transfer Score over Time from Outlines.

Consistent with the expected distribution, the descriptive statistics table indicates high skew and kurtosis in the concept map transfer score. Figure 8 provides a visual indicator of imbalance among the data.

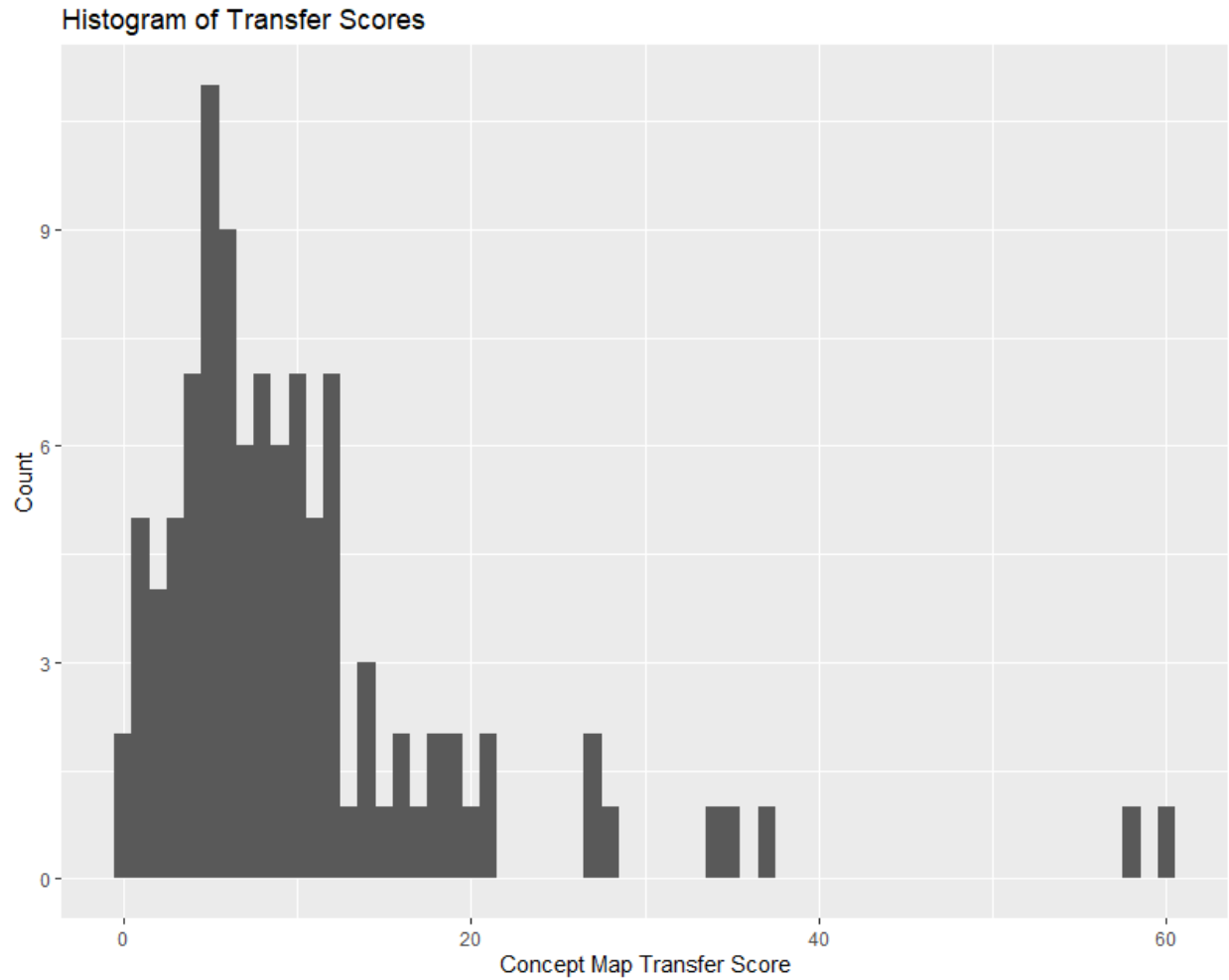


Figure 8. Distribution of Transfer Scores.

As the dependent variable is count data, I considered a Poisson or negative binomial regression model. One issue with Poisson regression is that it is not the best fit if data are overdispersed. To test this, I used the R package, *AER* (Kleiber & Zeileis, 2008). If dispersion is greater than one, the data is considered overdispersed. Regressing time and intervention on transfer scores, I found significant overdispersion using the Poisson distribution ( $\rho = 2.92$ ,  $p < .001$ ). Therefore, I used a negative binomial distribution which introduces a term in the model,  $\theta$ , to adjust for overdispersion.

As my research questions address population-level effects, I used generalized estimating equations (GEE) to test my hypothesis. GEE provides the best estimate for longitudinal studies focusing on population averages (Ballinger, 2004). To account for serial correlation within subjects, I tested various working correlation structures in the GEE model. Using the quasi-likelihood under the independence model criterion (QIC), the first-order autoregression (AR1) structure provided the best fit.

### **Hypotheses 1, 2a, and 2b**

Hypothesis 1 stated that controlling for concept map structural scores, age, sense of self, reflective aptitude, and relational ability, transfer of learning will improve after learners receive feedback on consecutive concept maps. Using negative binomial GEE, I found no significant difference on transfer over time ( $\beta = -.002$ , 95%  $CI[-.054, .50]$ ,  $p = .94$ ). Likewise, I found no significant results for hypothesis 2a. Hypothesis 2a stated that controlling for concept map structural scores, age, sense of self, reflective aptitude, and relational ability, learners' transfer scores will immediately increase when referencing themselves in concept maps. However, the initial self-reference intervention had no immediate effect on transfer scores ( $\beta = -.066$ , 95%  $CI[-.36, .23]$ ,  $p = .66$ ). While the first two hypotheses examined the main effects of time and intervention, hypothesis 2b examined the interaction between the two variables. Hypothesis 2b stated that controlling for concept map structural scores, age, sense of self, reflective aptitude, and relational ability, learners' transfer scores will grow over time when referencing themselves in concept maps. I found a significant positive difference in growth over time after the intervention ( $\beta = .63$ , 95%  $CI[.44, .82]$ ,  $p < .001$ ,  $IRR = 1.88$ ). On average, across all concept map assignments after the self-reference intervention, learners increased the number of concepts transferred to the written assignment by a factor of 1.88—or nearly doubled the number of

concepts transferred before the intervention. This finding suggests that while participants initially did not increase transfer after the intervention, the repeated activity of referencing oneself in a concept map led to increased transfer over time. This finding verifies the visual representation in Figure 6.

### **Hypotheses 3, 4, 5, and 6**

The remaining hypotheses examine whether age and various latent constructs influence growth over time after the intervention. Hypothesis 3 stated that older learners would have greater transfer of learning growth rates than younger learners after the self-reference intervention. Using the same negative binomial model, I found that older learners did not have a greater transfer of learning growth rates than younger learners ( $\beta = -.018$ , 95%  $CI[-.03, -.009]$ ,  $p < .001$ ,  $IRR = .982$ ). Interestingly, while there was a significant difference in the interaction with age, the findings suggest the opposite is true. However, the effect of age is marginal. On average, across all concept map transfer assignments after the self-reference intervention, younger learners increased the number of concepts transferred to the written assignment by less than 2% compared to older learners. Hypothesis 4 stated that the higher a learner's reflective aptitude, the more self-reference will contribute to the growth of transfer of learning. I found no significant difference between reflective aptitude and the growth of learning transfer ( $\beta = -.024$ , 95%  $CI[-.02, .008]$ ,  $p = .145$ ). While aptitude for self-reflection was not a factor for the influence of self-reference on learning transfer, a learner's sense of self does moderate self-reference and learning transfer growth. Hypothesis 5 stated that the higher a learner's sense of self, the more self-reference will contribute to the growth of learning transfer. Findings suggest that the higher a person's sense of self, the more likely self-reference in concept mapping will influence the growth of learning transfer ( $\beta = .185$ , 95%  $CI[.06, .31]$ ,  $p = .005$ ,  $IRR = 1.20$ ). For every standard

deviation increase on the Sense of Self Scale (SOSS), learners increased the number of words transferred over time after treatment by 20%. Finally, hypothesis 6 stated that the higher a learner's relational ability, the more self-reference will contribute to the growth of learning transfer. I found no significant difference between relational ability and the growth of learning transfer after intervention ( $\beta = .052$ , 95%  $CI[-.11, .22]$ ,  $p = .53$ ). Appendix B lists each iterative model in a table with beta coefficients (log-means), 95% confidence intervals, and QIC.

## **Conclusion**

While I did not find evidence to support five of the seven hypotheses, findings suggest self-reference in concept maps influences transfer given time. Additionally, a learner's sense of self appears to moderate the effect of the intervention over time. Interestingly, age appeared to have the opposite intended effect, with younger learners more likely to increase transfer with self-reference over time than older learners. However, the effect is negligible. The next chapter interprets and discusses these findings while providing recommendations for practice and future research.

## **Chapter 5 – Summary and Discussion**

In this chapter, I provide a summary of the study's purpose and problem, research questions, literature review, methodology, and findings. I then discuss the limitations of the study. Next, I interpret and discuss the implications of the findings and explore possible explanations and contributions to theory. I discuss how these findings inform practice and provide a foundation for future research. Finally, I close with a brief conclusion.

### **Summary**

#### **Purpose & Problem**

The purpose of this study was to investigate whether self-reference in concept mapping influences learning transfer over time in an authentic classroom setting. I extend the Roessger et al. (2021) study, which found that self-reference in concept mapping influences recall of concepts. While recall is a valuable learning outcome, many in the adult learning community have encouraged researchers to study learning transfer (Daley, 2001; Foley & Kaiser, 2013; Merriam & Leahy, 2005). Both concept mapping and autobiographical elaboration—or self-reference in learning activities—have empirical support for aiding transfer. However, this study is the first to examine the influence of self-reference in concept mapping on learning transfer. This study also builds upon relational frame theory in education and provides much needed empirical support for adult learning strategies.

#### **Research Questions**

Centering on the relationship between self-reference and transfer, I asked whether self-reference in concept mapping influenced transfer in adult students. The conceptual and empirical literature suggests that this activity may lead to positive learning transfer, consistently cited as a desirable learning outcome in adult learning. Specifically, I asked the following six questions:

1. After repeated practice and feedback, does concept mapping affect the transfer of learning?
2. After repeated practice and feedback, does self-reference in concept maps affect transfer of learning?
3. Is there an interaction between self-reference in concept maps and a learner's age on the growth of learning transfer?
4. Is there an interaction between self-reference in concept maps and a learner's reflective aptitude on the growth of learning transfer?
5. Is there an interaction effect between self-reference in concept maps and sense of self on the growth of learning transfer?
6. Is there an interaction effect between self-reference in concept maps and a learner's relational ability on the growth of learning transfer?

### **Literature Review**

While reviewing the literature, I examined the conceptual and empirical literature on concept mapping, the self-reference effect, and transfer. Additionally, I examined potential moderating factors such as age, sense of self, reflective aptitude, and relational ability. I found many studies demonstrating positive individual effects of concept mapping and self-reference on various learning outcomes. Furthermore, the literature suggests that age, aptitude for reflection, the ability to relate concepts to one another, and possessing a strong sense of self may moderate the self-reference effect. While one study examined the influence of self-reference in concept mapping on recall (Roessger et al., 2021), no study examined the effects on transfer. However, the literature suggests increased learning outcomes for participants who use a relational frame



approach to concept mapping (Roessger et al., 2018), which informed the decision to use this approach in the study.

## **Methodology**

I used a segmented, repeated-measures design to answer my questions. Over 16 weeks, participants completed a concept map on a different topic related to adult learning principles. One week after completing the concept map, participants wrote a brief essay applying the concept map topic to a real-life scenario. I assessed transfer by counting the number of concepts used in the written assignment present in the previous concept map assignment. Participants completed eight concept maps and eight written assignments.

Before finishing the first concept map, participants completed a survey that gathered data for age, Flury's Sense of Self Score, and Grant's Self Reflection and Insight – Self Reflection subscale score. Participants also completed the Relational Abilities Index+. Additionally, I provided video instruction on creating concept maps and using relational frames within concept maps. Before the fifth concept map, I introduced instruction on self-reference as an intervention. After completing each concept map, I provided feedback on the structure of the concept map, including feedback for self-referencing after the intervention.

Accounting for historical bias, participants also completed a separate outline assignment and subsequent written assignment. As outlines do not have substantial evidence for influencing transfer, I used this activity to act as a control, ensuring the introduction of self-reference—rather than an unknown external event—influenced participants' transfer scores. Although 16 students agreed to participate, only 13 students complied.

## **Findings**

I found evidence to support two of the seven hypotheses in this study, including the central question of whether self-reference in concept mapping influences learning transfer. Interestingly, there was no immediate increase in transfer after the intervention. However, transfer increased significantly after subsequent time points, suggesting that feedback may be necessary for introducing self-reference in concept mapping. The outline assignment control showed no transfer effect after the intervention, suggesting there were no external events. Additionally, findings suggest that a person's sense of self is a significant moderator. After the self-reference intervention, those with a higher sense of self increased the number of concepts transferred more than those with a lower sense of self.

## **Conclusions**

Based on the study's findings, I draw five conclusions. I present each conclusion with the related research questions and results.

### **Conclusion 1 – Concept Maps and Transfer**

My first research question asked, "After repeated practice and feedback, does concept mapping affect the transfer of learning?" The purpose of this question was to assess whether concept maps—with feedback and practice, but without the self-reference condition—improved learning transfer over time. Previous research suggests concept mapping improves transfer outcomes more than other learning activities (Nesbit & Adesope, 2006). Roessger et al. (2018) also found repeated feedback and practice with concept mapping increases the chances of recall. However, this study did not find a significant change in the transfer of learning over eight repeated measures. Therefore, the study's findings suggest that repeated practice with concept mapping and instructor feedback does not improve learning transfer outcomes. For instructors

aiming to increase transfer, concept maps are a helpful activity. Nevertheless, learners may not further develop the ability to transfer over time with only repeated practice and feedback.

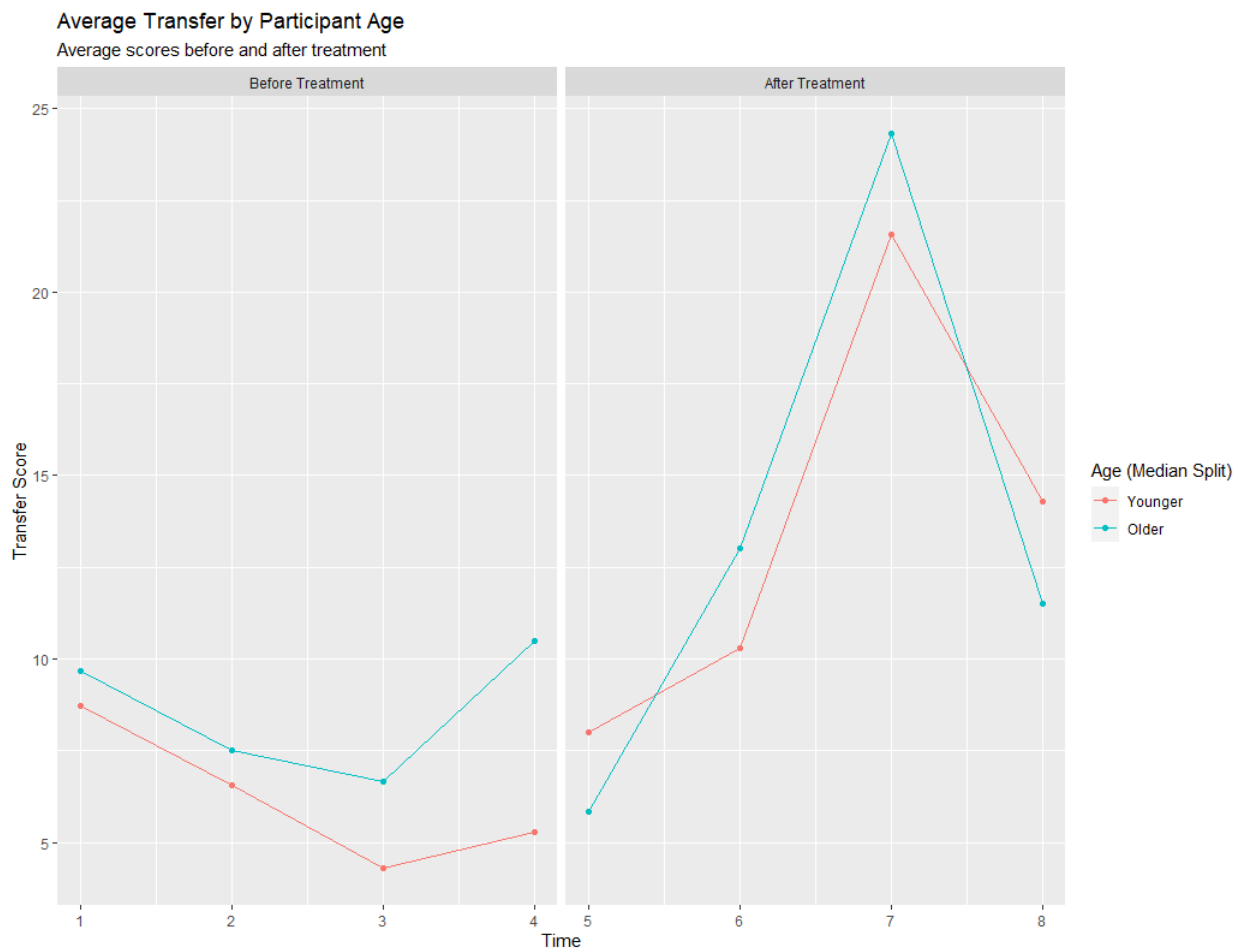
### **Conclusion 2 – Self-reference, Concept Maps, and Transfer**

In line with the focus of this study, I examined the relationship between self-reference in concept maps and transfer. I asked the following question: After repeated practice and feedback, does self-reference in concept maps affect transfer of learning? While there was no significant change in transfer immediately after the self-reference treatment, transfer increased in the subsequent measures. This finding suggests that learners may need an adjustment period after learning how to self-reference in concept mapping for transfer to occur. The nonsignificant findings from the outline assignment mitigate the chances of external influence on transfer rates. Therefore, the findings demonstrate that self-reference in concept mapping likely improves transfer over time, but learners may need sufficient practice for self-reference to influence transfer.

### **Conclusion 3 – Self-reference and Age**

With significant literature on the relationship between age and self-reflection, I asked, “Is there an interaction between self-reference in concept maps and a learner’s age on the growth of learning transfer?” I hypothesized that the older the learner, the more self-reference would influence transfer. Surprisingly, I found significant results suggesting the opposite is true. The younger the learner, the more self-reference influenced transfer. However, while the result is statistically significant, the effect size is marginal (about a 2% additional increase in the transfer of concepts over time for younger learners). To visualize the difference in ages, I created a new variable based on a median split of age. The new variable separated learners into “Younger” learners, participants who are at the median age or less, and “Older” learners above the median

age. I then graphed transfer over time before and after the treatment, separated by the age of learners.

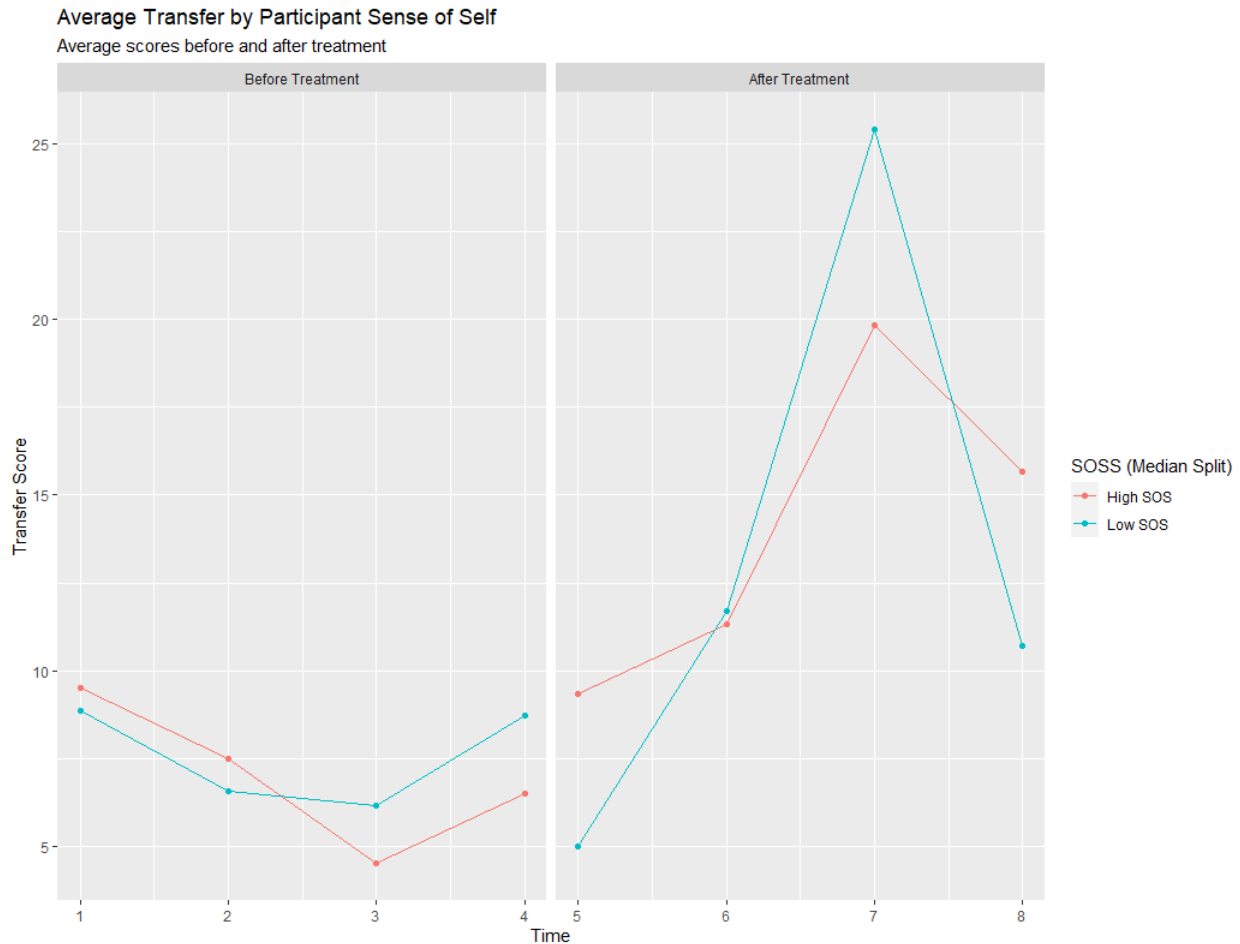


*Figure 9.* Average Transfer over Time by Participant Age Before and After Treatment (N = 13).

Based on the graph, younger learners performed slightly worse than older learners before the treatment. After the treatment, however, transfer scores jumped to the same levels as older learners and continued roughly on the same trajectory. The more unsatisfactory performance of younger learners before the intervention may explain the minor variance between older and younger learners.

#### **Conclusion 4 – Self-reference and The Self**

The literature review discussed the empirical and conceptual connections between sense of self, self-reflection, and the self-reference effect. These connections led me to ask the following two questions: a) Is there an interaction between self-reference in concept maps and a learner's reflective aptitude on the growth of learning transfer? And, b) is there an interaction effect between self-reference in concept maps and sense of self on the growth of learning transfer? I did not find an interaction between self-reference in concept maps and reflective aptitude. However, I did find a significant interaction between self-reference in concept maps and sense of self. A learner's reflective aptitude is unlikely to moderate transfer when self-referencing in concept maps based on these results. A learner's sense of self, on the other hand, likely does influence transfer when self-referencing in concept maps.



*Figure 10. Average Transfer over Time by Participant Sense of Self Before and After Treatment (N = 13).*

Figure 10 shows a slight drop in transfer immediately after self-reference for low sense of self learners and a slight rise in transfer immediately after self-reference for high sense of self learners. Both continue an upward trajectory after the treatment. Therefore, while self-reference in concept mapping benefits both types of learners, it may be more beneficial to learners with a stronger sense of self.

### **Conclusion 5 – Self-reference and Relational Ability**

My last research question focused on the relationship between relational ability and self-reference in concept mapping and its influence transfer. I asked, “Is there an interaction effect

between self-reference in concept maps and a learner's relational ability on the growth of learning transfer?" I did not find a significant interaction between a learner's relational ability and self-reference in concept maps on the growth of transfer. This finding suggests that educators seeking to teach transfer may not need to consider a learner's ability to relate concepts when teaching self-reference in concept mapping.

### **Limitations**

The above conclusions must be interpreted in the context of this study's limitations. Here, I discuss five limitations of the study that may prevent generalization. First, the study's sample was drawn from graduate students in a professionally-focused adult education program. These students took the course online. Due to the unique backgrounds of these students, findings may not generalize to different types of learners. Second, slightly less than half of the class chose not to participate in the study or were removed from the final dataset. Therefore, this was not a random sample and may bias results. Third, I focused on the learning intervention's influence on transfer, but the transfer I measured is closer to near transfer than far transfer. Learners could apply their knowledge to a different assignment across a short period—one week. However, both learning assignments covered the same topic and were in the same class. Further research would need to determine the influence on different types of transfer and time to transfer. Fourth, as a pre-post design, there is the possibility of historical effects bias. While the outline assignment acted as a control, learners may have been influenced by an event other than the treatment, particularly since transfer was not immediate after the treatment. Finally, readers must use caution when interpreting the results of the between-subjects effects. While age and sense of self had a significant interaction with the treatment on transfer, the small number of participants likely biases these findings.

## Discussion

For conclusions 1 and 2, I found that while practice and feedback alone did not affect transfer, self-reference in concept mapping did. Interestingly, there was no statistical difference between scores immediately after the treatment. Instead, transfer scores trended upward following the first post-treatment measure. This finding suggests that learners likely need an adjustment period to learn how to self-reference in concept mapping, or the effects of self-reference on transfer are not meaningful without practice and feedback. Fortunately, this study used a repeated measures design and was able to detect a temporal effect.

Conclusions 3, 4, and 5 discussed the implications for interactions between certain characteristics of learners and the influence of self-reference in concept mapping on transfer. As mentioned in the limitations, however, the small number of participants makes these findings less generalizable. Keeping limitations in mind, the finding that the influence of age was the opposite of my hypothesis was interesting. While the marginal effect size makes the finding practically nonsignificant, I am curious about the relationship between age and sense of self, given the positive sense of self finding. There is a moderate negative correlation between age and sense of self between participants in this study ( $r = -.41$ )—the older the learner, the lower the SOSS score.

However, further research—with different questions and larger samples—is needed to investigate this relationship. Within an RFT framework, the SOSS more closely measures the “conceptualized self,” or the self defined by a person’s relationship with their environment. Likewise, in Kegan’s theory of development, the SOSS more closely aligns with the assessment of Stage 3 and Stage 4 development. These developmental stages are marked by how a person’s identity is formed. Stage 3 indicates a shared identity with others, and Stage 4 represents the development of a personalized identity with institutional characteristics. Using Kegan’s



framework, older participants in this study may be in Stage 3 development. Although older, their sense of self may not be well defined. However, in the RFT literature—specifically its extension into Acceptance and Commitment Therapy (ACT)—a strong conceptualized self might indicate psychological rigidity. People are often restrained by their conceptualized self, unable to detach from potentially destructive relationships between their identity and an event. In Chapter 2, I used the example of Richard, who related “being bad at school” as part of his identity. Richard underwent a functional change with that relationship. However, without the functional change, Richard may not have successfully pursued his goals.

Regardless of the functional change, a person with a more developed self in ACT perceives their thoughts and history as distinct from their identity; they can learn to progress beyond a conceptualized self and embrace a “knowing self” or “transcendental self.” For example, mindfulness meditation is a common technique used to help decenter thoughts from a person’s selfhood. Notably, the mental exercise of projecting one’s thoughts onto an object—such as letters in a stream or placards in a parade—can aid a person’s development into the “knowing self.” Perhaps, then, sense of self as measured by the SOSS is biased by these higher-order perceptions of self. A person who perceives their self as secure, yet fluid, may not score as high on the SOSS, despite demonstrating developmental progress. Although speculative, this could explain discrepancies between age and sense of self scores.

While the influence of sense of self on the self-reference effect requires further research, this study contributes to the ongoing literature on the efficacy of the self-reference effect. Within an RFT framework, increased transfer of self-referenced concepts can be explained as a meaning-making process that centers the self and experience—one in which concepts related to the self are more strongly reinforced than concepts that are not. As educators, we can implement

a *functional pedagogy*<sup>1</sup> that leverages these relationships between self and experience, creating learning interventions that reinforce new concepts and ideas by creating, strengthening, or changing their relationship with the self. To this end, this study is a small step in making progress toward a contextual science of learning.

## **Implications for Practice and Research**

### **Recommendations for Teaching and Practice**

Findings indicate that self-reference in concept mapping may improve transfer for adult students. However, there may be a delay in improvement, which requires further reinforcement through feedback. This is likely true when the practice is new to students. In this study, participants completed concept maps using relational frames rather than the traditional approach advocated by Novak and Gowin (1984). Therefore, students were introduced not only to concept maps, but the approach to constructing concept maps was new to many, if not all, participants. The introduction to this new activity may be overwhelming, at first, for students. Hence, time and feedback are likely crucial for the effects of self-reference to manifest. These findings build on Roessger et al. (2018), who demonstrated the importance of feedback for improving broader learning outcomes with concept mapping.

Additionally, a person's sense of self likely influences how well self-reference affects learning outcomes. Fivush (2011) argues that autobiographical memory—key to self-reference—relies on developing a strong sense of self. Practitioners might consider their student demographics before implementing self-reference in concept mapping. For example, students

---

<sup>1</sup> a contextual science and practice of learning that seeks to develop and implement evidence-based learning interventions specific to a student's unique learning repertoire.

with certain mental health conditions that affect self-concept or older students with significant cognitive decline may not benefit as much from self-reference.

### **Recommendations for further research**

While these findings may lead to numerous additional investigations, I specifically note four significant opportunities for further study. Studies with larger samples and different populations are needed to make definitive conclusions on between-subjects effects, as noted in the limitations section. While this study found significant interactions between sense of self and age with treatment over time, the small number of participants warrants cautious interpretation. Therefore, replication studies with larger samples are needed to substantiate these effects. Additionally, more robust causal designs—such as comparative interrupted time series designs—would further strengthen or diminish a causal argument for increased transfer by self-reference in concept mapping.

Furthermore, this study took a broad approach to self-reference. Instructions to participants provided flexibility in how they referenced themselves. For example, a participant could reference a concept as a trait of themselves or relate it to an experience. It would be interesting to see if the type of self-reference moderates transfer or other learning outcomes. For example, Klein (2012b) suggests that referenced experiences—through autobiographical memory—provide a stronger connection in memory. However, many studies also demonstrate the efficacy of referencing traits.

While findings warrant further study on the moderating effect of sense of self, its relationship with learning is primed for further study. Most empirical studies focus on self-reference as a mnemonic device for recall. However, many latent constructs around self-concept—including sense of self, self-efficacy, and even self-reflection—may provide insight

into the relationship between self-reference and learning outcomes. Notably, further work on measuring these constructs and their antecedents could explain how a person's selfhood differentiates learning, providing personalized and contextual learning opportunities. For example, although this study did not find evidence of reflective aptitude as a moderator, a carefully constructed assessment based on a functional definition of reflection, as it is defined in education—such as Roessger's (2017) meaning-making criteria, would be a valuable tool for exploring causes of reflective aptitude and its effects on learning outcomes.

Finally, this study demonstrated that self-reference in concept mapping might influence transfer. However, I did not compare this learning strategy to other techniques. Although concept mapping has a lengthy body of evidence, studies have shown that other techniques—such as retrieval practice—are more effective at learning (Karpicke & Blunt, 2011; Lechuga et al., 2015). Additionally, some studies have shown that combining these methods improves learning outcomes, although retrieval practice seems to be the primary driver for recall (Blunt & Karpicke, 2014; Ortega-Tudela et al., 2019). Therefore, researchers could investigate whether self-reference provides an additive benefit to a combination of learning strategies.

## **Conclusion**

This chapter provided a summary of the study, extrapolated conclusions based on the findings, addressed limitations, discussed how these conclusions relate to broader theory and empirical research, and offered recommendations for practice and further study. Overall, the findings suggest that self-reference in concept mapping does influence learning transfer. While sense of self may moderate this effect, replication with a larger sample would need to strengthen this argument. This study has implications for those who teach concept mapping, and further study may provide insights into the relationship between the self and learning outcomes. The

findings add to the literature on relational frame theory in adult learning, contribute to the learning sciences, and further a pragmatic and scientific perspective in the adult learning discipline.

## References

- Allan, K., Morson, S., Dixon, S., Martin, D., & Cunningham, S. J. (2017). Simulation-Based Mentalizing Generates a “proxy” Self-Reference Effect in Memory. *Quarterly Journal of Experimental Psychology*, 70(6), 1074–1084. <https://doi.org/10.1080/17470218.2016.1209532>
- Anderson, N. H. (1968). Likableness ratings of 555 personality-trait words. *Journal of Personality and Social Psychology*, 9(3), 272–279. <https://doi.org/10.1037/h0025907>
- Anohina, A., & Grundspenkis, J. (2009, June). Scoring Concept Maps: An Overview. *CompSysTech '09 Proceedings of the International Conference on Computer Systems and Technologies and Workshop for PhD Students in Computing*. <https://doi.org/10.1145/1731740.1731824>
- Argyris, C., & Schön, D. (1996). *Organizational learning II: Theory, method, and practice*. Addison-Wesley Pub. Co.
- Ausubel, D. G. (1963). Cognitive Structure and the Facilitation of Meaningful Verbal Learning. *Journal of Teacher Education*, 14(2), 217–222. <https://doi.org/10.1177/002248716301400220>
- Ausubel, D. G. (2000). *The Acquisition and Retention of Knowledge: A cognitive view*. Kluwer Academic Publishers.
- Azur, M. J., Stuart, E. A., Frangakis, C., & Leaf, P. J. (2011). Multiple imputation by chained equations: What is it and how does it work? *International Journal of Methods in Psychiatric Research*, 20(1), 40–49. <https://doi.org/10.1002/mpr.329>
- Baddeley, A. (1992). Working Memory. *Science*, 255(5044), 556–559.
- Baldwin, T. T., & Ford, J. K. (1988). Transfer of Training: A Review and Directions for Future Research. *Personnel Psychology*, 41(1), 63–105. <https://doi.org/10.1111/j.1744-6570.1988.tb00632.x>
- Ballinger, G. A. (2004). Using Generalized Estimating Equations for Longitudinal Data Analysis. *Organizational Research Methods*, 7(2), 127–150. <https://doi.org/10.1177/1094428104263672>
- Barlow, M. C. (1937). Transfer of training in reasoning. *Journal of Educational Psychology*, 28(2), 122–128. <https://doi.org/10.1037/h0060789>
- Barnes-Holmes, D., Hayes, S. C., & Dymond, S. (2001). Self and self-directed rules. In S. C. Hayes, D. Barnes-Holmes, & B. Roche (Eds.), *Relational Frame Theory: A Post-Skinnerian Account of Human Language and Cognition* (pp. 119–139). Kluwer Academic Publishers.

- Barnes-Holmes, Y., Foody, M., Barnes-Holmes, D., & McHugh, L. (2013). Advances in Research on Deictic Relations and Perspective-Taking. In S. Dymond & B. Roche (Eds.), *Advances in Relational Frame Theory: Research and Application* (pp. 127–148). Context Press/New Harbinger Publications.
- Berzonsky, M., & Sullivan, C. (1992). Social-Cognitive Aspects of Identity Style: Need for Cognition, Experiential Openness, and Introspection. *Journal of Adolescent Research*, 7(2), 140–155.
- Biglan, A., & Hayes, S. C. (1996). Should the behavioral sciences become more pragmatic? The case for functional contextualism in research on human behavior. *Applied and Preventive Psychology*, 5(1), 47–57. [https://doi.org/10.1016/S0962-1849\(96\)80026-6](https://doi.org/10.1016/S0962-1849(96)80026-6)
- Blume, B. D., Ford, J. K., Baldwin, T. T., & Huang, J. L. (2010). Transfer of Training: A Meta-Analytic Review. *Journal of Management*, 36(4), 1065–1105. <https://doi.org/10.1177/0149206309352880>
- Blunt, J. R., & Karpicke, J. D. (2014). Learning with retrieval-based concept mapping. *Journal of Educational Psychology*, 106(3), 849–858. <https://doi.org/10.1037/a0035934>
- Boud, D., Keogh, R., & Walker, D. (1985). Promoting Reflection in Learning: A Model. In D. Boud, R. Keogh, & D. Walker (Eds.), *Reflection: Turning experience into learning* (pp. 18–40). Nichols Publishing Group.
- Broad, M. L. (1997). *Transferring Learning to the Workplace*. American Society for Training and Development.
- Brookfield, S. (1991). The development of critical reflection in adulthood: Foundations of a theory of adult learning. *New Education*, 13(1), 39–48.
- Brookfield, S. (2016). So Exactly What is Critical About Critical Reflection? In J. Fook, V. Collington, F. Ross, G. Ruch, & L. West (Eds.), *Researching Critical Reflection and Research: Multidisciplinary Perspectives* (pp. 11–22). Routledge.
- Burke, L. A., & Hutchins, H. M. (2007). Training Transfer: An Integrative Literature Review. *Human Resource Development Review*, 6(3), 263–296. <https://doi.org/10.1177/1534484307303035>
- Buuren, S. van, & Groothuis-Oudshoorn, K. (2011). mice: Multivariate Imputation by Chained Equations in R. *Journal of Statistical Software*, 45(3), 1–67.
- Carson, N., Murphy, K. J., Moscovitch, M., & Rosenbaum, R. S. (2016). Older adults show a self-reference effect for narrative information. *Memory*, 24(9), 1157–1172. <https://doi.org/10.1080/09658211.2015.1080277>

- Cassidy, S., Roche, B., Colbert, D., Stewart, I., & Grey, I. M. (2016). A relational frame skills training intervention to increase general intelligence and scholastic aptitude. *Learning and Individual Differences*, 47, 222–235. <https://doi.org/10.1016/j.lindif.2016.03.001>
- Cassidy, S., Roche, B., & Hayes, S. C. (2011). A Relational Frame Training Intervention to Raise Intelligence Quotients: A Pilot Study. *The Psychological Record*, 61(2), 173–198. <https://doi.org/10.1007/BF03395755>
- Cassidy, S., Roche, B., & O’Hora, D. (2010). Relational Frame Theory and Human Intelligence. *European Journal of Behavior Analysis*, 11(1), 37–51. <https://doi.org/10.1080/15021149.2010.11434333>
- Chabeli, M. (2010). Concept-mapping as a teaching method to facilitate critical thinking in nursing education: A review of the literature. *Health SA Gesondheid*, 15(1). <https://doi.org/10.4102/hsag.v15i1.432>
- Ciarrochi, J., Bilich, L., & Godsell, C. (2010). Psychological flexibility as a mechanism of change in Acceptance and Commitment Therapy. In R. Baer (Ed.), *Assessing Mindfulness and Acceptance: Illuminating the Processes of Change* (pp. 51–76). New Harbinger.
- Clarà, M. (2015). What Is Reflection? Looking for Clarity in an Ambiguous Notion. *Journal of Teacher Education*, 66(3), 261–271. <https://doi.org/10.1177/0022487114552028>
- Colbert, D., Dobutowitsch, M., Roche, B., & Brophy, C. (2017). The proxy-measurement of intelligence quotients using a relational skills abilities index. *Learning and Individual Differences*, 57, 114–122. <https://doi.org/10.1016/j.lindif.2017.03.010>
- Colbert, D., Malone, A., Barrett, S., & Roche, B. (2019). The Relational Abilities Index+: Initial Validation of a Functionally Understood Proxy Measure for Intelligence. *Perspectives on Behavior Science*. <https://doi.org/10.1007/s40614-019-00197-z>
- Conway, M. A. (2005). Memory and the self. *Journal of Memory and Language*, 53(4), 594–628. <https://doi.org/10.1016/j.jml.2005.08.005>
- Creswell, J. W., & Creswell, J. D. (2018). *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches* (5th ed.). SAGE Publications, Inc.
- Cunningham, S. J., Brebner, J. L., Quinn, F., & Turk, D. J. (2014). The Self-Reference Effect on Memory in Early Childhood. *Child Development*, 85(2), 808–823. <https://doi.org/10.1111/cdev.12144>
- Daley, B. J. (2001). Learning and Professional Practice: A Study of Four Professions. *Adult Education Quarterly*, 52(1), 29–54. <https://doi.org/10.1177/074171360105200104>



- Daley, B. J. (2010). Concept Maps: Practice Applications in Adult Education and Human Resource Development. *New Horizons in Adult Education and Human Resource Development*, 24(2–4), 7.
- Daley, B. J., Conceição, S. C. O., Mina, L., Altman, B. A., Baldor, M., & Brown, J. (2010). Integrative Literature Review: Concept Mapping: A Strategy to Support the Development of Practice, Research, and Theory Within Human Resource Development. *Human Resource Development Review*, 9(4), 357–384. <https://doi.org/10.1177/1534484310379101>
- Daley, B. J., Morgan, S., & Black, S. (2016). Concept Maps in Nursing Education: A Historical Literature Review and Research Directions. *Journal of Nursing Education*, 55(11), 631–639. <https://doi.org/10.3928/01484834-20161011-05>
- Daley, B. J., & Torre, D. M. (2010). Concept maps in medical education: An analytical literature review. *Medical Education*, 44(5), 440–448. <https://doi.org/10.1111/j.1365-2923.2010.03628.x>
- Dennett, D. C. (1978). Beliefs about beliefs [P&W, SR&B]. *Behavioral and Brain Sciences*, 1(4), 568–570.
- Detterman, D. K., & Sternberg, R. J. (1993). *Transfer on trial: Intelligence, cognition, and instruction*. Ablex Pub. Corp.
- Dewey, J. (1910). *How We Think*. D.C. Heath & Co.
- dos Santos, V., Ferreira de Souza, E., Vijaykumar, N., & Felizardo, K. (2017). Analyzing the Use of Concept Maps in Computer Science: A Systematic Mapping Study. *Informatics in Education*, 16(2). <https://doi.org/10.15388/infedu.2017.13>
- Dumas, D., Alexander, P. A., & Grossnickle, E. M. (2013). Relational Reasoning and Its Manifestations in the Educational Context: A Systematic Review of the Literature. *Educational Psychology Review*, 25(3), 391–427. <https://doi.org/10.1007/s10648-013-9224-4>
- Dunkel, C. S., & Lavoie, J. C. (2005). Ego-identity and the processing of self-relevant information. *Self & Identity*, 4(4), 349–359. <https://doi.org/10.1080/15298860500220542>
- Dymond, S., & Roche, B. (Eds.). (2013). *Advances in Relational Frame Theory*. Context Press/New Harbinger Publications.
- Ebbinghaus, H. (1913). *Memory: A Contribution to Experimental Psychology* (H. Ruger & C. Bussenius, Trans.). Teachers College, Columbia University.
- Elbaz, F. (1988). Critical Reflection on Teaching: Insights from Freire. *Journal of Education for Teaching*, 14(2), 171–181. <https://doi.org/10.1080/0260747880140205>

- Erikson, E. H. (1959). *Identity and the life cycle: Selected papers*. International Universities Press.
- Fivush, R. (2011). The Development of Autobiographical Memory. *Annual Review of Psychology*, 62(1), 559–582. <https://doi.org/10.1146/annurev.psych.121208.131702>
- Flury, J. M. (2004). *The Sense of Self Scale (SOSS): Development and validation* [Dissertation]. The University of Texas at Arlington.
- Flury, J. M., & Ickes, W. (2007). Having a Weak Versus Strong Sense of Self: The Sense of Self Scale (SOSS). *Self & Identity*, 6(4), 281–303. <https://doi.org/10.1080/15298860601033208>
- Foley, J. M., & Kaiser, L. M. R. (2013). Learning Transfer and Its Intentionality in Adult and Continuing Education. *New Directions for Adult and Continuing Education*, 2013(137), 5–15. <https://doi.org/10.1002/ace.20040>
- Ford, J. K., & Weissbein, D. A. (1997). Transfer of Training: An Updated Review and Analysis. *Performance Improvement Quarterly*, 10(2), 22–41. <https://doi.org/10.1111/j.1937-8327.1997.tb00047.x>
- Fox, E. J. (2006). Constructing a Pragmatic Science of Learning and Instruction with Functional Contextualism. *Educational Technology, Research and Development*, 54(1), 5–36. <https://doi.org/10.1007/s11423-006-6491-5>
- Freire, P. (2000). *Pedagogy of the Oppressed* (M. B. Ramos, Trans.; 30th Anniversary Edition). Continuum.
- Gagné, R. M., Foster, H., & Crowley, M. E. (1948). The measurement of transfer of training. *Psychological Bulletin*, 45(2), 97–130. <https://doi.org/10.1037/h0061154>
- Gardiner, J. C., Luo, Z., & Roman, L. A. (2009). Fixed effects, random effects and GEE: What are the differences? *Statistics in Medicine*, 28(2), 221–239. <https://doi.org/10.1002/sim.3478>
- Grant, A. M. (2001). Rethinking Psychological Mindedness: Metacognition, Self-reflection, and Insight. *Behaviour Change*, 18(1), 8–17. <https://doi.org/10.1375/bech.18.1.8>
- Grant, A. M., Franklin, J., & Langford, P. (2002). The Self Reflection and Insight Scale: A new measure of private self-consciousness. *Social Behavior and Personality: An International Journal*, 30(8), 821–836. <http://dx.doi.org/10.2224/sbp.2002.30.8.821>
- Grilli, M. D., & Glisky, E. L. (2010). Self-imagining enhances recognition memory in memory-impaired individuals with neurological damage. *Neuropsychology*, 24(6), 698–710. <https://doi.org/10.1037/a0020318>

- Groninger, L. D., & Groninger, L. K. (1988). Autobiographical Episodes as Mediators in the Recall of Words. *The American Journal of Psychology*, 101(4), 515–538. <https://doi.org/10.2307/1423229>
- Habermas, J. (1984). *The Theory of Communicative Action: Reason and the rationalization of society*. Beacon Press.
- Hanley, J. A., Negassa, A., Edwardes, M. D. deB., & Forrester, J. E. (2003). Statistical Analysis of Correlated Data Using Generalized Estimating Equations: An Orientation. *American Journal of Epidemiology*, 157(4), 364–375. <https://doi.org/10.1093/aje/kwf215>
- Haskell, R. E. (2001). *Transfer of Learning: Cognition, Instruction, and Reasoning*. Academic Press. [http://cachescan.bcub.ro/e-book/v03/580718\\_1.pdf](http://cachescan.bcub.ro/e-book/v03/580718_1.pdf)
- Hayes, S. C., Barnes-Holmes, D., & Roche, B. (Eds.). (2001). *Relational Frame Theory: A Post-Skinnerian Account of Human Language and Cognition*. Springer Science+Business Media.
- Hayes, S. C., Barnes-Holmes, D., & Wilson, K. G. (2012). Contextual Behavioral Science: Creating a science more adequate to the challenge of the human condition. *Journal of Contextual Behavioral Science*, 1(1–2), 1–16. <https://doi.org/10.1016/j.jcbs.2012.09.004>
- Hayes, S. C., & Gregg, J. (2000). Functional Contextualism and the Self. In C. Muran (Ed.), *Self-relations in the psychotherapy process* (pp. 291–307). American Psychological Association.
- Hayes, S. C., Hayes, L. J., & Reese, H. W. (1988). Finding the philosophical core: A review of Stephen C. Pepper's World Hypotheses. *Journal of the Experimental Analysis of Behavior*, 50, 97–111.
- Hayes, S. C., & Long, D. M. (2013). Contextual Behavioral Science, Evolution, and Scientific Epistemology. In S. Dymond & B. Roche (Eds.), *Advances in Relational Frame Theory* (pp. 5–26). Context Press/New Harbinger Publications.
- Hayes, S. C., Strosahl, K. D., & Wilson, K. G. (2012). *Acceptance and Commitment Therapy: The Process and Practice of Mindful Change* (2nd ed.). The Guilford Press.
- Heathcote, D. (2016). Working memory and performance limitations. In D. Groome & M. Eysenck, *An Introduction to Applied Cognitive Psychology* (2nd edition, pp. 99–124). Psychology Press.
- Heugten, C. M. van, Ponds, R. W. H. M., & Kessels, R. P. C. (2016). Brain training: Hype or hope? *Neuropsychological Rehabilitation*, 26(5–6), 639–644. <https://doi.org/10.1080/09602011.2016.1186101>

- Hofstadter, D. (2001). Epilogue: Analogy as the Core of Cognition. In D. Gentner, K. J. Holyoak, & B. N. Kokinov (Eds.), *The Analogical Mind: Perspectives from Cognitive Science* (pp. 449–538). The MIT Press.
- Hubbard, A. E., Ahern, J., Fleischer, N. L., Van der Laan, M., Satariano, S. A., Jewell, N., Bruckner, T., & Satariano, W. A. (2010). To GEE or Not to GEE: Comparing Population Average and Mixed Models for Estimating the Associations Between Neighborhood Risk Factors and Health. *Epidemiology*, 21(4), 467–474.
- Hunt, R. R., & Einstein, G. O. (1981). Relational and item-specific information in memory. *Journal of Verbal Learning and Verbal Behavior*, 20(5), 497–514.  
[https://doi.org/10.1016/S0022-5371\(81\)90138-9](https://doi.org/10.1016/S0022-5371(81)90138-9)
- Jablokow, K. W., DeFranco, J. F., & Richmond, S. S. (2013, June). *A Statistical Study of Concept Mapping Metrics*. 120th ASEE Annual Conference & Exposition, Atlanta.
- James, W. (1890). *The Principles of Psychology* (Vol. 1). Project Gutenberg.  
<https://www.gutenberg.org/files/57628/57628-h/57628-h.htm>
- Jordi, R. (2011). Reframing the Concept of Reflection: Consciousness, Experiential Learning, and Reflective Learning Practices. *Adult Education Quarterly*, 61(2), 181–197.  
<https://doi.org/10.1177/0741713610380439>
- Karpicke, J. D., & Blunt, J. R. (2011). Retrieval Practice Produces More Learning than Elaborative Studying with Concept Mapping. *Science*, 331(6018), 772–775.  
<https://doi.org/10.1126/science.1199327>
- Kegan, R. (1982). *The evolving self*. Harvard University Press.
- Kegan, R. (2009). What “form” transforms? A constructive-developmental approach to transformative learning. In K. Illeris (Ed.), *Contemporary theories of learning* (pp. 35–52). Routledge.
- Kihlstrom, J. F., Albright, J. S., Klein, S. B., Cantor, N., Chew, B. R., & Niedenthal, P. M. (1988). Information Processing and the Study of the Self. In L. Berkowitz (Ed.), *Advances in Experimental Social Psychology* (Vol. 21, pp. 145–178). Academic Press.
- Kinchin, I. M. (2014). Concept Mapping as a Learning Tool in Higher Education: A Critical Analysis of Recent Reviews. *Journal of Continuing Higher Education*, 62(1), 39–49.  
<https://doi.org/10.1080/07377363.2014.872011>
- King, P. M., & Kitchener, K. S. (2004). Reflective Judgment: Theory and Research on the Development of Epistemic Assumptions Through Adulthood. *Educational Psychologist*, 39(1), 5–18. [https://doi.org/10.1207/s15326985ep3901\\_2](https://doi.org/10.1207/s15326985ep3901_2)

- Kitchenham, A. (2008). The Evolution of John Mezirow's Transformative Learning Theory. *Journal of Transformative Education*, 6(2), 104–123. <https://doi.org/10.1177/1541344608322678>
- Kleiber, C., & Zeileis, A. (2008). *Applied Econometrics with R*. Springer-Verlag. <https://CRAN.R-project.org/package=AER>
- Klein, S. B. (2012a). The Self and Its Brain. *Social Cognition*, 30(4), 474–518. <https://doi.org/10.1521/soco.2012.30.4.474>
- Klein, S. B. (2012b). Self, Memory, and the Self-Reference Effect: An Examination of Conceptual and Methodological Issues. *Personality and Social Psychology Review*, 16(3), 283–300. <https://doi.org/10.1177/1088868311434214>
- Klein, S. B., Loftus, J., & Burton, H. A. (1989). Two self-reference effects: The importance of distinguishing between self-descriptiveness judgments and autobiographical retrieval in self-referent encoding. *Journal of Personality and Social Psychology*, 56(6), 853–865. <https://doi.org/10.1037/0022-3514.56.6.853>
- Klein, S. B., & Nichols, S. (2012). Memory and the Sense of Personal Identity. *Mind*, 121(483), 677–702. <https://doi.org/10.1093/mind/fzs080>
- Knowles, M. S. (1970). *The modern practice of adult education: Andragogy versus pedagogy*. Association Press.
- Knowles, M. S., Holton, E. L., & Swanson, R. A. (2015). *The Adult Learner: The definitive classic in adult education and human resource development* (8th ed.). Routledge.
- Kolb, D. A. (2015). *Experiential Learning: Experience as the Source of Learning and Development* (2nd ed.). Pearson Education.
- Kuiper, N. A. (1981). Convergent evidence for the self as a prototype: The “inverted—U RT effect” for self and other judgments. *Personality and Social Psychology Bulletin*, 7(3), 438–443. <https://doi.org/10.1177/014616728173012>
- Lachner, A., Backfisch, I., & Nückles, M. (2018). Does the accuracy matter? Accurate concept map feedback helps students improve the cohesion of their explanations. *Educational Technology Research and Development*, 66(5), 1051–1067. <https://doi.org/10.1007/s11423-018-9571-4>
- Lachner, A., Burkhart, C., & Nückles, M. (2017). Mind the gap! Automated concept map feedback supports students in writing cohesive explanations. *Journal of Experimental Psychology: Applied*, 23(1), 29–46. <https://doi.org/10.1037/xap0000111>

- Lechuga, M. T., Ortega-Tudela, J. M., & Gómez-Ariza, C. J. (2015). Further evidence that concept mapping is not better than repeated retrieval as a tool for learning from texts. *Learning and Instruction, 40*, 61–68. <https://doi.org/10.1016/j.learninstruc.2015.08.002>
- Lee, Y. S. (2010). Functional Criticism: A Guide to Critiques in the Graphic Design Classroom. *Design Principles and Practices: An International Journal, 4*(1), 401–408. <https://doi.org/10.18848/1833-1874/CGP/v04i01/37809>
- Linville, P. W. (1985). Self-Complexity and Affective Extremity: Don't Put All of Your Eggs in One Cognitive Basket. *Social Cognition; New York, 3*(1), 94–120. <http://0-dx.doi.org.library.uark.edu/10.1521/soco.1985.3.1.94>
- Lipshitz, R. (2000). Chic, Mystique, and Misconception: Argyris and Schön and the Rhetoric of Organizational Learning. *The Journal of Applied Behavioral Science, 36*(4), 456–473. <https://doi.org/10.1177/0021886300364004>
- Lombardo, M. V., Barnes, J. L., Wheelwright, S. J., & Baron-Cohen, S. (2007). Self-referential cognition and empathy in autism. *PloS One, 2*(9), e883. <https://doi.org/10.1371/journal.pone.0000883>
- Macrae, C. N., Moran, J. M., Heatherton, T. F., Banfield, J. F., & Kelley, W. M. (2004). Medial prefrontal activity predicts memory for self. *Cerebral Cortex (New York, N.Y.: 1991), 14*(6), 647–654. <https://doi.org/10.1093/cercor/bhh025>
- Marcia, J. E. (1966). Development and validation of ego-identity status. *Journal of Personality and Social Psychology, 3*(5), 551–558. <https://doi.org/10.1037/h0023281>
- Mead, G. H. (1934). *Mind, Self, and Society: From the Standpoint of a Social Behaviorist*. University of Chicago Press.
- Merriam, S. B., Caffarella, R. S., & Baumgartner, L. M. (2007). *Learning in adulthood: A comprehensive guide*. Jossey-Bass.
- Merriam, S. B., & Leahy, B. (2005). Learning Transfer: A Review of the Research in Adult Education and Training. *PAACE Journal of Lifelong Learning, 14*.
- Mezirow, J. (1990). How Critical Reflections triggers Transformative Learning. In J. Mezirow & Associates, *Fostering Critical Reflection in Adulthood: A Guide to Transformative and Emancipatory Learning* (pp. 1–20). Jossey-Bass.
- Mezirow, J. (1997). Transformative Learning: Theory to Practice. *New Directions for Adult and Continuing Education, 1997*(74), 5–12. <https://doi.org/10.1002/ace.7401>
- Mezirow, J. (1998). On Critical Reflection. *Adult Education Quarterly, 48*(3), 185–198.

- Michelson, E. (2011). Autobiography and Selfhood in the Practice of Adult Learning. *Adult Education Quarterly*, 61(1), 3–21. <https://doi.org/10.1177/0741713609358447>
- Moreno, R., & Mayer, R. E. (2000). Engaging Students in Active Learning: The Case for Personalized Multimedia Messages. *Journal of Educational Psychology*, 92(4), 724–733. <https://doi.org/10.1037/0022-0663.92.4.724>
- Morse, D., & Jutras, F. (2008). Implementing Concept-based Learning in a Large Undergraduate Classroom. *CBE—Life Sciences Education*, 7(2), 243–253. <https://doi.org/10.1187/cbe.07-09-0071>
- Muth, C., Bales, K. L., Hinde, K., Maninger, N., Mendoza, S. P., & Ferrer, E. (2016). Alternative Models for Small Samples in Psychological Research. *Educational and Psychological Measurement*, 76(1), 64–87. <https://doi.org/10.1177/0013164415580432>
- Nesbit, J. C., & Adesope, O. O. (2006). Learning With Concept and Knowledge Maps: A Meta-Analysis. *Review of Educational Research*, 76(3), 413–448. <https://doi.org/10.3102/00346543076003413>
- Novak, J. D., & Cañas, A. J. (2006). The Origins of the Concept Mapping Tool and the Continuing Evolution of the Tool. *Information Visualization*, 5(3), 175–184. <https://doi.org/10.1057/palgrave.ivs.9500126>
- Novak, J. D., & Cañas, A. J. (2008). *The Theory Underlying Concept Maps and How to Construct and Use Them* [Technical]. Florida Institute for Human & Machine Cognition. <http://cmap.ihmc.us/docs/theory-of-concept-maps.php>
- Novak, J. D., & Gowin, D. B. (1984). *Learning how to learn*. Cambridge University Press.
- O’Hora, D., Peláez, M., Barnes-Holmes, D., Rae, G., Robinson, K., & Chaudhary, T. (2008). Temporal Relations and Intelligence: Correlating Relational Performance With Performance on the Wais-III. *The Psychological Record*, 58(4), 569–584. <https://doi.org/10.1007/BF03395638>
- Ortega-Tudela, J. M., Lechuga, M. T., & Gómez-Ariza, C. J. (2019). A specific benefit of retrieval-based concept mapping to enhance learning from texts. *Instructional Science*, 47(2), 239–255. <https://doi.org/10.1007/s11251-018-9476-y>
- Parker, D. A. (2021a). *Code for Dissertation Analysis* [R]. <https://github.com/daparker26/dissertation>
- Parker, D. A. (2021b). *cxlAnalyze: Reads, parses, and analyzes CXL concept map files* (0.1.2) [R]. <https://github.com/daparker26/cxlAnalyze>

- Parker, D. A., & Roessger, K. M. (2020). Self-Directed Learning and Retrieval Practice: Building a Bridge through Functional Contextualism. *International Journal of Lifelong Education*, 39(2), 205–218. <https://doi.org/10.1080/02601370.2020.1743375>
- Pepper, S. C. (1942). *World Hypotheses: A Study in Evidence*. University of California Press.
- Philippi, C. L., Duff, M. C., Denburg, N. L., Tranel, D., & Rudrauf, D. (2012). Medial PFC Damage Abolishes the Self-reference Effect. *Journal of Cognitive Neuroscience*, 24(2), 475–481. [https://doi.org/10.1162/jocn\\_a\\_00138](https://doi.org/10.1162/jocn_a_00138)
- Pierce, W. D., & Cheney, C. D. (2008). *Behavior Analysis and Learning* (4th ed.). Psychology Press/Taylor & Francis.
- Prebble, S. C. (2014). *Autobiographical memory and sense of self* [Ph.D. dissertation]. University of Auckland.
- Premack, D., & Woodruff, G. (1978). Does the chimpanzee have a theory of mind? *Behavioral and Brain Sciences*, 1(4), 515–526. <https://doi.org/10.1017/S0140525X00076512>
- R Core Team. (2019). *R: A Language and Environment for Statistical Computing*. R Foundation for Statistical Computing. <https://www.R-project.org/>
- Rodgers, C. (2002). Defining Reflection: Another Look at John Dewey and Reflective Thinking. *Teachers College Record*, 104(4), 842–866. <https://doi.org/10.1111/1467-9620.00181>
- Roessger, K. M. (2013). *Investigating the impact of formal reflective activities on skill adaptation in a work-related instrumental learning setting* [Ph.D. dissertation]. The University of Wisconsin - Milwaukee.
- Roessger, K. M. (2014). The Effects of Reflective Activities on Skill Adaptation in a Work-Related Instrumental Learning Setting. *Adult Education Quarterly*, 64(4), 323–344. <https://doi.org/10.1177/0741713614539992>
- Roessger, K. M. (2017). Establishing a functional conceptualisation of reflection's meaning making criterion. *Studies in the Education of Adults*, 49(1), 75–91. <https://doi.org/10.1080/02660830.2017.1283784>
- Roessger, K. M. (2019). Towards a taxonomy of meaning making: A critical latent content analysis of peer-reviewed publications in adult education. *New Horizons in Adult Education and Human Resource Development*, 31(3), 4–24. <https://doi.org/10.1002/nha3.20254>
- Roessger, K. M., Daley, B. J., & Hafez, D. A. (2018). Effects of teaching concept mapping using practice, feedback, and relational framing. *Learning and Instruction*, 54, 11–21. <https://doi.org/10.1016/j.learninstruc.2018.01.011>



- Roessger, K. M., Greenleaf, A., Moy, G., & Phan, V. (2019). *Connecting to the self: Self-referential learning, reflective activities, and the adult learner*. [Manuscript in review].
- Roessger, K. M., Moy, G., Bristow, S., Phan, V., Campbell, H., & Parker, D. A. (2021). Multi-level factors affecting immediate and delayed concept recall in concept mapping with adult learners. *Educational Psychology, 41*(2), 224–244.  
<https://doi.org/10.1080/01443410.2020.1806211>
- Rogers, T. B. (1981). A Model of the Self as an Aspect of the Human Information Processing System. In N. Cantor & J. F. Kihlstrom (Eds.), *Personality, Cognition and Social Interaction* (p. 23). Lawrence Erlbaum Associates.
- Rogers, T. B., Kuiper, N. A., & Kirker, W. S. (1977). Self-reference and the encoding of personal information. *Journal of Personality and Social Psychology, 35*(9), 677–688.  
<https://doi.org/10.1037/0022-3514.35.9.677>
- Roumell, E. A. (2019). Priming Adult Learners for Learning Transfer: Beyond Content and Delivery. *Adult Learning, 30*(1), 15–22. <https://doi.org/10.1177/1045159518791281>
- Schön, D. (1983). *The Reflective Practitioner: How professionals think in action*. Basic Books, Inc.
- Schroeder, N. L., Nesbit, J. C., Anguiano, C. J., & Adesope, O. O. (2018). Studying and Constructing Concept Maps: A Meta-Analysis. *Educational Psychology Review, 30*(2), 431–455. <https://doi.org/10.1007/s10648-017-9403-9>
- Schwendimann, B. A., & Linn, M. C. (2015). Comparing two forms of concept map critique activities to facilitate knowledge integration processes in evolution education. *Journal of Research in Science Teaching, 53*(1), 70–94. <https://doi.org/10.1002/tea.21244>
- Shadish, W. R., Cook, T. D., & Campbell, D. T. (2002). *Experimental and quasi-experimental designs for generalized causal inference*. Houghton Mifflin.
- Sinatra, A. M., Sottolare, R. A., & Sims, V. K. (2014). *The Impact of Need for Cognition and Self-Reference on Tutoring a Deductive Reasoning Skill*: (Experiment ARL-TR-6961). Army Research Laboratory. <https://doi.org/10.21236/ADA603248>
- Singley, M. K., & Anderson, J. R. (1989). *The Transfer of Cognitive Skill*. Harvard University Press.
- Skinner, B. F. (1976). *About Behaviorism*. Random House.
- SREB. (2020). *Who is the Adult Learner?* Southern Regional Education Board.  
<https://www.sreb.org/general-information/who-adult-learner>

- Sui, J., & Humphreys, G. W. (2015). The Integrative Self: How Self-Reference Integrates Perception and Memory. *Trends in Cognitive Sciences*, 19(12), 719–728. <https://doi.org/10.1016/j.tics.2015.08.015>
- Symons, C. S., & Johnson, B. T. (1997). The Self-Reference Effect in Memory: A Meta-Analysis. *Psychological Bulletin*, 121(3), 371–394.
- Thorndike, E. L., & Woodworth, R. S. (1901). The influence of improvement in one mental function upon the efficiency of other functions: III. Functions involving attention, observation and discrimination. *Psychological Review*, 8(6), 553–564. <https://doi.org/10.1037/h0071363>
- Tonhäuser, C., & Büker, L. (2016). Determinants of Transfer of Training: A Comprehensive Literature Review. *International Journal for Research in Vocational Education and Training*, 3(2), 127–165.
- Törneke, N. (2010). *Learning RFT: An introduction to relational frame theory and its clinical application*. Context Press/New Harbinger Publications.
- Tulving, E. (1972). Semantic and Episodic Memory. In E. Tulving & W. Donaldson (Eds.), *Organization of Memory* (pp. 381–403). Academic Press.
- Tulving, E. (1985). *Elements of episodic memory*. Oxford University Press.
- Usher, R., Bryant, I., & Johnston, R. (1997). *Adult Education and the Postmodern Challenge: Learning Beyond the Limits*. Routledge.
- Van Beveren, L., Roets, G., Buysse, A., & Rutten, K. (2018). We all reflect, but why? A systematic review of the purposes of reflection in higher education in social and behavioral sciences. *Educational Research Review*, 24, 1–9. <https://doi.org/10.1016/j.edurev.2018.01.002>
- Wallace, J. D., & Mintzes, J. J. (1990). The concept map as a research tool: Exploring conceptual change in biology. *Journal of Research in Science Teaching*, 27(10), 1033–1052. <https://doi.org/10.1002/tea.3660271010>
- Warren, M. W., Chattin, D., Thompson, D. D., & Tomskey, M. T. (1983). The effects of autobiographical elaboration on noun recall. *Memory & Cognition*, 11(5), 445–455. <https://doi.org/10.3758/BF03196981>
- West, D. C., Park, J. K., Pomeroy, J. R., & Sandoval, J. (2002). Concept mapping assessment in medical education: A comparison of two scoring systems. *Medical Education*, 36(9), 820–826. <https://doi.org/10.1046/j.1365-2923.2002.01292.x>
- Wickham, H. (2016). *ggplot2: Elegant Graphics for Data Analysis*. Springer-Verlag New York. <https://ggplot2.tidyverse.org>

- Wickham, H., Averick, M., Bryan, J., Chang, W., McGowan, L. D., François, R., Grolemund, G., Hayes, A., Henry, L., Hester, J., Kuhn, M., Pedersen, T. L., Miller, E., Bache, S. M., Müller, K., Ooms, J., Robinson, D., Seidel, D. P., Spinu, V., ... Yutani, H. (2019). Welcome to the tidyverse. *Journal of Open Source Software*, 4(43), 1686. <https://doi.org/10.21105/joss.01686>
- Wisco, B. E. (2009). Depressive cognition: Self-reference and depth of processing. *Clinical Psychology Review*, 29(4), 382–392. <https://doi.org/10.1016/j.cpr.2009.03.003>
- Woodrow, H. (1927). The effect of type of training upon transference. *Journal of Educational Psychology*, 18(3), 159–172. <https://doi.org/10.1037/h0071868>
- Yaoi, K., Osaka, M., & Osaka, N. (2015). Neural correlates of the self-reference effect: Evidence from evaluation and recognition processes. *Frontiers in Human Neuroscience*, 9. <https://doi.org/10.3389/fnhum.2015.00383>
- Yelich Biniecki, S. M., & Conceição, S. C. O. (2016). Using Concept Maps to Engage Adult Learners in Critical Analysis. *Adult Learning*, 27(2), 51–59. <https://doi.org/10.1177/1045159515604148>
- Yue, M., Zhang, M., Zhang, C., & Jin, C. (2017). The effectiveness of concept mapping on development of critical thinking in nursing education: A systematic review and meta-analysis. *Nurse Education Today*, 52, 87–94. <https://doi.org/10.1016/j.nedt.2017.02.018>
- Zhu, H. (2021). *kableExtra: Construct Complex Table with “kable” and Pipe Syntax*. <https://CRAN.R-project.org/package=kableExtra>

## Appendix A: Feedback Script

*Table 3. Prepared feedback addressing participant concept map composition. Adapted from Roessger et al. (2018, p. 16).*

Performance Area	Correct	Incorrect
Concepts	Excellent job using single concepts in your circles	Can you only include single concepts within a circle rather than phrases that contain multiple concepts?
Crosslinks	You are doing an excellent job of communicating the directions of your relationships using arrowheads on your crosslinks	Can you include arrows on your crosslinks to communicate the direction of your relations?
Linking Words	Great job including linking words on all your cross links!	Can you incorporate linking words on your cross links?
Propositional Language Units	Excellent job forming meaningful language units when relating concepts!	Can you try to use meaning language units when linking concepts? When you relate two concepts with linking words, the two concepts and the linking words should form a proposition (i.e. a sentence of sorts). You should be able to read “concept 1” “linking words” concept 2” as a meaningful sentence.
Cross-Map Relations	Good use of cross map links (horizontal connections across your map)!	Can you try in your next map to increase the number of cross map links (horizontal connections across your map)? This may lead to new insights and applications of concepts.
Progressive Differentiation	I really appreciate how you are differentiating your concepts into their parts!	Can you think about further differentiating a concept into its parts, so that its parts are also concepts that can be

*Table 3. Prepared feedback addressing participant concept map composition. Adapted from Roessger et al. (2018, p. 16).(Cont.)*

Performance Area	Correct	Incorrect
		related to other concepts? This would likely give your map more depth and cause you to dive further into these ideas.
Relational Framing	Good use of a variety of relational frames in your map.	Can you try to incorporate a broader range of relational frames in your future maps?
<b>Self-reference (post intervention)</b>	Excellent job incorporating personal experience in your map!	Can you try to incorporate personal experience into your future maps?

## Appendix B: GEE Models

Table 4. Generalized Estimating Equations with Negative Binomial Distribution.

<i>Predictors</i>	<b>Model 1</b>		<b>Model 2</b>		<b>Model 3</b>		<b>Model 4</b>		<b>Model 5</b>		<b>Model 6</b>		<b>Model 7</b>	
	$\beta$	<i>CI</i>	$\beta$	<i>CI</i>	$\beta$	<i>CI</i>	$\beta$	<i>CI</i>	$\beta$	<i>CI</i>	$\beta$	<i>CI</i>	$\beta$	<i>CI</i>
Time	-.002	-.054 – .050	.008	-.069 – .085	-.292***	-.443 – .141	-.730***	-1.05 – .558	-.322***	-.416 – .228	-.293***	-.446 – .141	-.293***	-.447 – .138
Age	-.008	-.021 – .050	-.009	-.022 – .004	-.005	.015 – .006	-.011	-.024 – .002	-.006	-.017 – .004	-.005	-.016 – .006	-.005	-.015 – .006
CM Structural Score	-.077	-.173 – .020	-.073	-.170 – .024	-.050	-.117 – .018	-.014	-.123 – .095	-.016	-.128 – .096	-.039	-.162 – .084	-.045	-.170 – .081
SRIS-SR	-.040	-.130 – .050	-.041	-.130 – .049	-.060	-.134 – .014	-.062	-.143 – .018	-.065	-.146 – .016	.096	-.174 – .366	-.064	-.141 – .012
SOSS	.060	-.086 – .207	.061	-.085 – .207	.047	-.072 – .167	.042	-.079 – .163	.282*	.060 – .504	.040	-.078 – .158	.047	-.068 – .162
RAI	-.012	-.192 – .168	-.014	-.194 – .167	-.009	-.144 – .126	-.032	-.169 – .105	-.025	-.157 – .107	-.013	-.143 – .117	.007	-.305 – .318
Treatment			-.066	-.358 – .226	-2.23***	-2.87 – -1.59	-4.40**	-6.96 – -1.85	-2.27***	-2.94 – -1.61	-2.19***	-2.86 – -1.53	-2.25***	-2.90 – -1.60
Time * Treatment					.631***	.440 – .822	1.48***	1.04 – 1.93	.662***	.509 – .814	.625***	.427 – .823	.632***	.438 – .827
Time * Age							.009*	.002 – .016						
Treatment * Age							.048	-.005 – .100						

Table 4. Generalized Estimating Equations with Negative Binomial Distribution. (Cont.)

Predictors	Model 1		Model 2		Model 3		Model 4		Model 5		Model 6		Model 7	
	$\beta$	CI	$\beta$	CI	$\beta$	CI	$\beta$	CI	$\beta$	CI	$\beta$	CI	$\beta$	CI
(Time * Treatment ) * Age							-.018***	-.028 – -.009						
Time * SOSS									-.210***	-.296 – -.125				
Treatment * SOSS									-.068	-.650 – .513				
(Time * Treatment ) * SOSS									.185**	.055 – .316				
Time * SRIS-SR											-.058	-.215 – .099		
Treatment * SRIS- SR											.094	-.636 – .824		
(Time * Treatment ) * SRIS- SR											.001	-.224 – .225		
Time * RAI													-.009	-.161 – .143
Treatment * RAI													-.262	-.822 – .358

Table 4. Generalized Estimating Equations with Negative Binomial Distribution. (Cont.)

<i>Predictors</i>	<b>Model 1</b>		<b>Model 2</b>		<b>Model 3</b>		<b>Model 4</b>		<b>Model 5</b>		<b>Model 6</b>		<b>Model 7</b>	
	$\beta$	<i>CI</i>	$\beta$	<i>CI</i>	$\beta$	<i>CI</i>	$\beta$	<i>CI</i>	$\beta$	<i>CI</i>	$\beta$	<i>CI</i>	$\beta$	<i>CI</i>
(Time * Treatment ) * RAI													.052	-.110 – .215
N <sub>Obs</sub>														
N <sub>Participants</sub>														
QIC	44.76		45.13		33.74		32.30		32.08		34.63		35.41	
* $p < 0.05$ ** $p < 0.01$ *** $p < 0.001$														



## Appendix C: IRB Approval



---

**To:** Kevin M Roessger  
BELL 4188

**From:** Douglas J Adams, Chair  
IRB Expedited Review

**Date:** 10/01/2020

**Action:** Expedited Approval

**Action Date:** 10/01/2020

**Protocol #:** 2004261801A001

**Study Title:** Does Self-Reference in Concept Mapping Influence Transfer?

**Expiration Date:** 04/09/2021

**Last Approval Date:** 10/01/2020

The above-referenced protocol has been approved following expedited review by the IRB Committee that oversees research with human subjects.

If the research involves collaboration with another institution then the research cannot commence until the Committee receives written notification of approval from the collaborating institution's IRB.

It is the Principal Investigator's responsibility to obtain review and continued approval before the expiration date.

Protocols are approved for a maximum period of one year. You may not continue any research activity beyond the expiration date without Committee approval. Please submit continuation requests early enough to allow sufficient time for review. Failure to receive approval for continuation before the expiration date will result in the automatic suspension of the approval of this protocol. Information collected following suspension is unapproved research and cannot be reported or published as research data. If you do not wish continued approval, please notify the Committee of the study closure.

**Adverse Events:** Any serious or unexpected adverse event must be reported to the IRB Committee within 48 hours. All other adverse events should be reported within 10 working days.

**Amendments:** If you wish to change any aspect of this study, such as the procedures, the consent forms, study personnel, or number of participants, please submit an amendment to the IRB. All changes must be approved by the IRB Committee before they can be initiated.

You must maintain a research file for at least 3 years after completion of the study. This file should include all correspondence with the IRB Committee, original signed consent forms, and study data.

cc: Daniel A Parker, Investigator