Summer 2020

The Impact of Guided Practice in Argument Analysis and Composition via Computer-Assisted Argument Mapping Software on Students' Ability to Analyze and Compose Evidence-Based Arguments

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THE IMPACT OF GUIDED PRACTICE IN ARGUMENT ANALYSIS AND COMPOSITION VIA COMPUTER-ASSISTED ARGUMENT MAPPING SOFTWARE ON STUDENTS' ABILITY TO ANALYZE AND COMPOSE EVIDENCE-BASED ARGUMENTS

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Submitted in Partial Fulfillment of the Requirements

For the Degree of Doctor of Education in

Curriculum and Instruction

College of Education

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2020

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DEDICATION

To my Lord and Savior, Jesus Christ who made me for a purpose and graced me with the ability to fulfill it

To my father, Donald B. Cooke, who gave me ambition, and my mother, Lorain W. Cooke, who gave me the strength and determination to satisfy it

To my husband, Benjamin, my son, John Thomas, and my daughter, Sarah, who sacrificed for it and cheered me on

To my mother and father-in-law, Anice S. Grant and Donald A. Grant, who facilitated it

And to my dogs, Argus and Lily, without whom I would have achieved my ambition, but lost my mind

Ingenuas didicisse fideliter artes emollit mores nec sinit esse feros.

--Ovid

ACKNOWLEDGEMENTS

I would like to acknowledge the guidance and support of those who helped me on this journey, Dr. Rhonda Jeffries, Donna Watson Morris, Dr. Suha Tamim, Dr. David Virtue, & my student participant researchers of the Graduating Class of 2020. For your exceptional guidance and assistance, I offer my sincere gratitude to each of you.

ABSTRACT

The purpose of this quantitative action research study was to document the impact of the use of computer-assisted argument mapping (CAAM) upon high school students' ability to analyze and compose evidence-based arguments. The study used a one-group pretest posttest design with a convenience sample of the participant researcher's seventy-one high school sophomores. During the six-week study, each participant generated four sets of artifacts, each consisting of two argument analysis maps from provided source arguments and one argument composition map representing the participant's position on the given topic. Artifacts were generated at four separate benchmarks, the pretest, week four, week five, and the posttest. Between the pretest and week four, students completed a self-paced computerized tutorial on critical thinking (CT) that emphasized argumentation skills, such as grouping ideas, the parts of an argument, locating arguments in a text, evaluating arguments for errors in logic and credibility, and creating argument maps. In weeks four and five of the study, students applied the skills learned in the tutorial to full-length argumentative articles provided by the participant researcher. Benchmarks for weeks four, five, and the posttest consisted of the same task as the pretest, two analysis maps reconstructing the authors' arguments and one argument composition map representing the participant's position on the given topic. Composite scores were analyzed to determine an overall effect, while each component score, analysis and composition, provided an indication of reading comprehension ability and argument construction ability, respectively. The use of CAAM as a means of fostering

the CT skills necessary for the comprehension and composition of arguments (analysis, synthesis, and organization) proved beneficial, with the results of the study showing both significance (t=7.7077, crit. t=1.67, $\propto = 05$, 95% confidence level) and an appreciable effect size (d = .9147).

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CHAPTER 1

INTRODUCTION

The ability to construct a sound argument has been an important intellectual tool and an instrument of social change since the Greeks honed their rhetoric in open-air amphitheaters centuries ago (Cline, 2006). Unfortunately, in the American public school classroom, argumentation has traditionally been superseded by exposition and narration (Brent, 2013). Yet, argumentation has become an essential 21st century skill with the advent of Common Core State Standards, South Carolina College- and Career-Readiness Standards, and changes in the Scholastic Aptitude Test (SAT) and the American College Test (ACT), all of which place emphasis on argumentative writing (ACT, 2016; College Board, 2016; National Governors Association Center for Best Practices and Council of Chief State School Officers, 2010; South Carolina Department of Education, 2015). The critical thinking (CT) skills associated with argumentation have pragmatic applications as well as academic ones. The ability to comprehend and evaluate others' arguments and to compose one's own is a practical necessity, for students will grow into consumers, voters, and advocates of social justice who will need to be able to weigh options and present their arguments effectively if they are to be informed participants in a 21st century global community (Baker, 2010; November, 2010; Rugg, 1921). In the tradition of Social Reconstructionist Harold Rugg's (1921) emphasis on critical analysis, fostering students' argumentation skills will prepare them "to assume intelligent control of their institutions and environment" (pp. 698-699; see also Spring, 2014, pp. 320-321).

There exists a fundamental connection among the act of research as high school students know it, argumentation, and CT that has guided the development of the present study. Lunsford et al.'s (2019) work *Everything's an Argument* contends that every communication is an attempt to convince someone of an idea. In that way, everything is an argument, whether formal or informal, strong or weak, logical or emotional. When students conduct research on a topic, they are gathering support for claims they make about that topic, even if the mode of writing is informative rather than argumentative. Therefore, the development of an argument is always the purpose of a research assignment. When students want to compose an argument, they must consider ideas beyond their own perspective, which requires research— whether formal or informal, strong or weak, logical or emotional. Research is an aspect of argumentation. Argumentation is the purpose of research. Furthermore, both research and argumentation employ CT skills, such as analysis, inference, evaluation, and synthesis. Thus, for the purpose of this study, research presumes argument, and argument presumes CT.

Statement of the Problem

Local Context

Different modes or genres of writing create different expectations within readers; therefore, students must be instructed in the conventions of each. The function of expository writing is to explain a topic with the intent of informing a reader or increasing the reader's understanding and its tone is neutral; whereas, the function of argumentation is to use logical reasoning, as opposed to the emotional appeals associated with persuasive writing, to convince the reader to adopt a viewpoint or to take an action (Jago, 2002; Kirszner, & Mandell, 2011; National Assessment Governing Board (NAGB),

2017). In this study's setting, students had been assigned expository research papers in ninth grade English I, so they were familiar with writing from sources when they entered tenth grade English II. However, they struggled with the transition to the argumentative task required of them in English II. Using irrelevant or unsupportive evidence to justify their claims, students continued to engage in expository discourse instead of developing a position on an issue. Because they did not understand the function of a counterargument, students either presented multiple sides of an argument completely in an expository manner, or they ignored other points of view altogether. Bacig, et al. (1991) noted this tendency toward exposition in their work. Also, students may have been suffering from an inability to fully comprehend the source material from which they were to gather evidence to support their claims.

Previous Instructional Efforts to Address Argumentation

The participant researcher and her colleagues have utilized various strategies to provide motivation, instruction, and scaffolding to aid students' efforts to conduct research and compose cogent, documented, evidenced-based arguments. Strategies have been based upon research on direct instruction (DI), modeling, student agency, and scaffolding. Traditionally, students had been taught research and argumentation through DI (Engelmann & Carnine, 1982; Hollingsworth & Ybarra, 2009) in formal note card creation, thesis development, and the use of MLA source documentation, with argumentation emphasized in college-preparatory level English III. Such traditional forms of instruction, never popular with students (Bergmann & Zepernick, 2007; Weber & Smithmier, 2008), began to fall out of favor with writing scholars in preference for more authentic writing experiences and the use of more electronic means of research and

composition (Elbow, 1998; Fletcher, R., 1993; Brown, J., 2000). In an effort to provide all students with a rigorous curriculum, our department's elimination of technical-preparatory level English classes provided a greater number of students the opportunity to acquire more rigorous research and argumentation skills. These two situations created a need to differentiate instruction to facilitate learning at all students' ability-levels.

In an effort of continuous improvement, our department sought other strategies to inform our practice. The theories mentioned in the following discussion are elaborated upon more fully in the theoretical framework section of this chapter and in Chapter 3. Vygotsky's (1978) application of social constructivism emphasized the social nature of learning, the use of modeling, and the use of scaffolding to support students' efforts to expand their abilities. The gradual release of responsibility (GRR) instructional model suggested that the provision and subsequent, incremental removal of instructional scaffolding can enable students to complete an academic task that they would otherwise be incapable of completing unaided (Pearson & Gallagher, 1983). Vygotsky's social constructivism and the GRR instructional model inspired our use of modeling, an aspect of DI, with freshmen in English I (Engelmann & Carnine, 1982; Hollingsworth & Ybarra, 2009; Pearson & Gallagher, 1983). Students were provided with identical source materials and walked through each stage of the writing process to produce an expository essay using a process similar to Berkowitz & Wayne Central School District, O. C. N.'s (1983) *Controlled Research Writing Project*.

The teacher would model the cognitive processes necessary to generate a thesis and a major section of the paper's body, and students were expected to repeat those cognitive processes as a group and then on their own to complete the paper. In this way,

students' papers would contain teacher-generated material, group-generated material, and material unique to each student. While this method did facilitate the production of adequate papers, students felt little ownership over the product. The internalization of skills requires an intrinsic motivation to adopt those behaviors (Deci & Ryan, 1985, 2000, 2002). Because they were denied a sense of personal agency in this assignment, students' motivations to enact the modeled skills were primarily extrinsically motivated, thereby precluding the internalization of skills that would enable students to transfer those skills to a different context (Ryan & Deci, 2000).

Deci and Ryan's (1985, 2002) self-determination theory (SDT) and Bandura's (1977, 1989, 1997) work on self-efficacy and student agency informed our decision to allow students choice in their researched writing assignments (Ryan & Deci, 2017). Both theories posit that increased student agency contributes to increased performance by fostering feelings of self-efficacy that lead to the internalization of learning goals (Bandura, 1977, 1989, 1997; Deci & Ryan, 1985, 2002; Ryan & Deci 2017). However, while our students may have experienced increased interest, performance did not automatically improve with the implementation of choice; students needed significant guidance in making choices that would both interest them and enable them to be successful in the creation of a cogent, evidenced-based argument (Flowerday & Schraw, 2003; Flowerday & Shell, 2015). Such scaffolding included limiting topics to ensure the selection of debatable issues and providing inquiry statements rather than just a topic (Vygotsky, 1978). An example of the transformation of a topic into an inquiry statement would be *Should gas powered lawn equipment be exempt from the emissions standards of*

cars? rather than *air pollution* or *gas-powered lawn equipment* (McKenna & McKenna, 2000).

Research and argument-building are reading-intensive activities, and the participant researcher was concerned that the development of students' argumentative abilities may have been hindered by an inability to comprehend the source material from which they were to glean supporting evidence. Flower (1989) found that the reading comprehension of non-fiction academic material is a challenge even for students who read on grade-level; therefore, providing strategies to increase reading comprehension should be a priority in research instruction. Rosenblatt's (1994/2005) transactional theory of literacy, which suggested that the reading of a particular genre can influence the reader's writing in that genre, was the basis for our use of exemplar texts in teaching argumentation. Through a close reading of expert exemplar texts, such as Patrick Henry's (1775/2006) *Speech to the Second Virginia Convention*, 23 March 1775 and Martin Luther King Jr.'s (1963/2006) *I Have a Dream* speech, students explored the elements of arguments and how they could be arranged effectively to influence a reader's thoughts.

Modeling the analysis of expert arguments increased students' ability to identify the use of rhetorical devices but did not develop students' ability to comprehend the argument structure of unfamiliar texts more deeply than the recognition of surface elements, such as rhetorical questions, repetition, and loaded language. Perhaps with multiple opportunities to practice analyzing expert arguments, students might have had the opportunity to begin to see among the expert arguments patterns of logic beneath the rhetorical devices, but the time required to teach significant portions of several complex arguments was prohibitive in a semester-long course not devoted solely to argumentation,

thus precluding the necessary opportunities to practice. Moreover, the process of transferring the ability to analyze an argument to the ability to write an argument was difficult even for undergraduate students in a semester-long course (Adler-Kassner & Estrem, 2007). Therefore, it was to be expected that secondary students would require more than one semester to internalize a skill taught primarily by observing and imitating expert models. Unfortunately, our secondary students were taught on a semester schedule that provided no more time than was afforded to Adler-Kassner and Estrem's, (2007) undergraduates, and students' task avoidance further exacerbated the problem of a lack of practice. Furthermore, Bandura (1971) noted that the use of proficient peer models proved to be more effective than expert models in increasing students' feelings of self-efficacy because it was easier for students to envision themselves successfully completing a task when they saw a successful peer than when they saw a more experienced adult performing the same task.

Though each of the strategies in our department's repertoire had some merit, none of the strategies have provided improvement in the CT skills, the reasoning ability, required to generate a cogent argument. To this end, the participant researcher sought to incorporate the best attributes of our previous methods with instruction that would address the necessary CT skills.

Study Rationale

According to current research, the merits of our previous instructional strategies in research and argumentation included collaboration, reading-to-write and writing-to-read, student choice, DI, and scaffolding strategies such as modeling and guided practice (Jackson, 2011; Marzano, 2017; Milner et al., 2017). To these, the participant researcher

wished to add strategies designed to increase opportunities for practicing research and argumentation skills, to increase reading comprehension, to develop the CT skills needed to compose evidence-based arguments, and to increase engagement in acquiring the aforementioned skills. The participant researcher discovered that Rationale computer-assisted argument mapping (CAAM) software combined many of the desired traits: multiple tutorials with short exercises in logical argumentation, the use of graphic organizers to depict argument structure, modeling, guided practice, and the use of computer technology (Critical Thinking Skills BV (CTS), 2013).

Critical Thinking (CT)

The participant researcher found that her concerns that students' CT skills and reading comprehension skills might have been hindering their argumentation ability were not incompatible, but rather aspects of the same concept (Dwyer 2010; Facione, 1990; Glaser, 1941; Harrell 2005a; Haller, 2010)**.** CT, of which argumentation is an aspect, is essentially the process of making inferences, which is the essence of reading comprehension (Anderson & Pearson, 1984/2002; Ausubel, 1963; Mill, 1843/1852; Wundt, 1897). Since explicit instruction in argumentation would have the concurrent benefit of improving reading comprehension, explicit instruction in CT should not be considered something extra to be added to ELA curriculum, but rather a fundamental component of that curriculum. That is not to say that ELA is the only place in the curriculum for CT. Argumentation and the accompanying CT subskills it requires, are essential to science, history, and even mathematics, particularly geometry (Buehl et al., 2014; Inouye & Houseal, 2018; Kuhn, 2010; Osbourne et al., 2004). Furthermore, Facione (1990), Andrews et al. (2009), and Hitchcock (2018) suggested that CT should

also be studied in its own right in the primary and secondary grades to prepare students for the level of CT required at the college level.

John Stuart Mill (1843/1882) and Wilhelm Wundt (1897) likened the mental process of generating ideas with chemical reactions. The brain comprehends new information through its connection to prior knowledge. Just as chemical interactions can produce unexpected results, interactions between old and new ideas can sometimes generate unexpected inferences that can either lead to error or expanded knowledge. This metaphor was codified by Ausubel's (1963) work on schema theory, which sought to further explain exactly how the connections among ideas were generated and recalled. In the same way that molecular models display the interactions among chemical elements, argument mapping provides a concrete, visual representation of one's mental process of connecting ideas (Bell, 1997).

Direct Instruction (DI)

The limited time frame of the present study (six weeks) necessitated an efficient as well as effective, intervention. Stockard et al's. (2018) meta-analysis confirmed that DI produced moderate to large effect sizes. DI is a teacher-centered method in which a teacher plans and delivers instruction that directs students' attention and thoughts about subject matter (Engelmann & Carnine, 1982; Hollingsworth & Ybarra, 2009)**.** DI combines aspects of Gagné et al.'s (1992) Nine Events of Instruction, which concerns itself with maximizing cognitive performance, and Vygotsky's (1978) use of scaffolding to effect learning within the zone of proximal development (ZPD). Two forms of scaffolding common to DI are guided practice and modeling.

Repetition & Guided Practice. The need for repetition or practice is recognized by behaviorists, cognitivists, and constructivists (Gagné et al., 1992; Skinner, 1938; Piaget, 1936/1977; Vygotsky, 1978). Increasing opportunities to practice the skills associated with research and argumentation needed to involve a multitude of much smaller assignments organized in increasing complexity to facilitate the acquisition of the required skills (Artman et al., 2010; Ericsson, 2004, 2020a, 2020b; Ericsson, & Charness, 1994; Ericsson et al., 1993; Hunter, 1982; Kuhlthau, 1988, 1991, 1994, 1995; Leckie, 1996; Rosenshine, 1995). While Artman et al. (2010) cautioned against perpetuating the idea that information literacy consists of disparate skills rather than an integrated mindset that includes the location, evaluation, and use of source material in myriad ways, they, nonetheless, recognize the need for repeated opportunities to engage in that process. The need for practice in acquiring CT skills is widely recognized; however, some scholars emphasize the importance of the students' mindset as a contributing factor to the success of such practice. Ericsson and Charness (1994) and Ericsson et al. (1993) insist that dedicated practice is required for the attainment of expertise. According to Ericsson (2020; et al, 1993), *dedicated practice* requires intense focus upon lessons designed by an expert to target specific aspects of performance during which a student repeats a skill to the point of mastery under the supervision of an expert coach who provides immediate feedback and corrective instruction during the practice session.

Pearson & Gallagher's (1983) GRR instructional model was employed to deliver instruction on the research process because of its provision of multiple scaffolded opportunities for students to practice discrete skills within the process, which was compatible with DI's interest in incremental presentation of learning material. In this

way, the intimidation factor was minimized by helping students to perceive of research assignments as a series of small yet interconnected acts rather than one overwhelming task (Kuhlthau, 1988, 1994, 1995). Rationale's tutorial feature provided structured, incremental, explicit instruction in the logical organization of ideas, which is one essential aspect of constructing an argument (Bacig et al., 1991; CTS, 2013; Dwyer et al., 2012; Hollingsworth & Ybarra, 2009; Toulmin, 2003).

The Rationale tutorial began with idea-sorting exercises and exercises analyzing small arguments, at times only a few sentences long, and progressed to more complex arguments (CTS, 2013). Such incremental instruction helped to manage students' cognitive load during the assimilation of new skills (Bacig et al., 1991; Gagné et al., 1992; Leckie, 1996; Sweller, 1988; Sweller et al., 1998, 2019). The number of mini-lessons contained in the tutorial, 53, provided ample opportunities for practice before students had to add another task to their cognitive load, the gathering of information to be organized into an argument presented in map form.

After the completion of a highly structured, self-paced tutorial, applying the CT skills practiced in the tutorial to the new task of analyzing and generating full-length arguments was conducted via expert modeling in direct, whole group instruction (Dwyer et al., 2012; Hollingsworth & Ybarra, 2009). Small groups or pairs then repeated the process with a different topic (Vygotsky, 1978). Students practiced a third time, with the option to work alone if desired. This option accommodated students who needed further practice before working alone and those who were ready to display mastery.

Modeling. Both DI lesson delivery strategies and constructivist learning theory emphasize the use of models to facilitate learning (Bandura, 1971, 1986, 1995; Gagné et

al., 1992; Vygotsky, 1978). Rationale's tutorial lessons provided students with model answers with which they could evaluate their work, thereby providing instant feedback (Bacig et al., 1991; CTS, 2013). Students were also able to learn simply by studying the worked solutions (Clark, R. et al., 2006; Paas et al., 2003). In addition to the provision of static visual models, the participant researcher used DI to model the transfer of the mapping skills from the tutorial to the analysis and composition of full-length arguments on socioscientific issues (Engelmann & Carnine, 1982, Gagné et al., 1992; Hollingsworth & Ybarra, 2009; Vygotsky, 1978). The participant researcher read a text aloud to the class and modeled the process of mapping out a reconstruction of the author's argument by informing participants of the next step and asking participants to provide the information required in each section of the argument. The modeling process was continued as participants were allowed to work with peers (Bandura, 1971, 1986, 1995; Vygotsky, 1978).

Graphic Organizers

From kindergarten through twelfth grade, our district emphasizes the use of graphic organizers as a tool to facilitate the organization and acquisition of ideas, so the participant researcher wanted to use them to help students anticipate the kinds of information they would encounter while reading arguments and the kind of information they would need to include while writing arguments (Haller, 2010; Harrell, 2005a & b; Hyerle & Yeager, 2007; Rosenblatt, 1994/2005). Rationale software facilitates the creation of such graphic organizers in the form of hierarchical, color-coded argument maps (CTS, 2013). In order to decrease cognitive load while emphasizing CT skills, students presented their arguments in chart form rather than composing a formal essay.

CT and composition are both challenging tasks. Eliminating one of those tasks allowed students to focus on the content of their arguments rather than the eloquence of their prose (Clark, R. et al., 2006; Suthers, 2914; Sweller, 1988; Sweller et al., 1998, 2019; van Gelder et al., 2004). Argument maps further ease cognitive load by taking advantage of gestalt principles, using nonverbal cues to facilitate the viewer's comprehension of complex systems of ideas (Clark, R. et al., 2006; Hyerle & Yeager, 2007; Sweller et al., 1998, 2019; Wertheimer, 1923/2012; Wigmore, 1913).

Engagement

The participant researcher has been concerned by observations of task avoidance regarding research and argumentation for over twenty years in education. However, scholars reveal that this is not simply adolescent laziness. Plato (376 BCE/1974), Bury (1913), Glaser (1941), Facione (2000), and hooks (2010), have all noted the human tendency to eschew the mental toil of discerning the truth of the ideas they encounter. The participant researcher wondered whether the avoidance was caused by a lack of skill rather than a lack of work ethic. Therefore, she decided to make the argumentative research paper a less overwhelming assignment by focusing on the meaning-making aspects of the process, such as the analysis and synthesis of source material and the construction of an evidence-based argument. Other necessary skills and processes, such as topic selection, locating and evaluating sources, and producing a formal essay, were eliminated. The use of argument maps as the presentation format was intended to decrease the cognitive load and accompanying anxiety associated with this cognitively demanding task, thereby increasing students' feelings of self-efficacy throughout the process from whole group instruction to individual performance (Clark, R. et al., 2006;

Kuhlthau, 1988, 1994; Sweller, 1988; Sweller 1998, 2019). The use of online instruction was intended to address Gagné's (1992) first event of instruction, reception, which can be achieved by presenting material in a novel manner. The district had gone 1:1 with student laptop computers the semester before the intervention was conducted, so the participant researcher hoped that the novelty value of online instruction would mitigate task avoidance (Taylor & Parsons, 2011).

Purpose Statement

The purpose of this action research study was to describe the impact of guided practice in argument analysis and composition via CAAM on tenth grade students' ability to analyze and compose evidence-based arguments. The first research objective was to establish students' baseline ability to analyze and compose evidence-based arguments via a pretest. The second research objective was to describe the impact of guided practice in argument analysis and composition via CAAM on students' ability to comprehend and analyze published arguments on social issues by observing and evaluating argument maps that the students generated from research articles. The third research objective was to describe the impact of guided practice in argument analysis and composition via CAAM on students' ability to compose evidence-based arguments based upon their composition and presentation of an evidence-based argument in the form of an argument map. The fourth research objective was to describe changes in student attitudes toward research and argumentation over the course of the intervention.

Research Questions

1. *What is the impact of the use of CAAM on high school students' ability to analyze evidence-based arguments?*

2. *What is the impact of the use of CAAM on high school students' ability to generate evidence-based arguments?*
3. *What is the impact of the use of CAAM on high school students' attitudes toward research and argumentation?*

Conceptual Framework

The conceptual framework that informed the present action research study included ideas from social reconstructionism, cognitivism, and constructivism. The brief descriptions that follow have been elaborated upon in the Chapter 2 literature review. The use of education to foster the ability to effect social justice reflects a social reconstructionist view (Freire, 1972). Cognitivism concerns itself with the function of the brain in processing data and the ways in which pedagogy can facilitate that process via strategies such as decreasing cognitive load and presenting information in small, purposefully organized units (Piaget, 1936/1977; Leckie, 1996). Constructivism emphasizes the individual's need to create meaning. While these theories may seem incompatible, informed eclecticism has been a pragmatic choice for many renowned scholars of psychology, research methods, and education, including Snelbecker (1974) who insisted that pedagogues cannot afford "the luxury of restricting [themselves] to only one theoretical position" (p. 8; see also Ertmer & Newby, 2013; Howie, 2008, 2014; Taggart, 1955; Tellings, 2001; Yanchar & Gabbitas, 2011; Yanchar & Williams, 2006; Zierer, 2010, 2011). Scholarship regarding eclecticism emphasized the need for informed and systematic decision-making when combining ideas from fundamentally opposed theories (Howie, 2008, 2014; Yanchar & Gabbitas, 2011). The following is an explanation of how the disparate theories informed this action research study.

Social Reconstructionism

That education is essential to democracy has been a theme throughout American history from Thomas Jefferson to bell hooks (79. A Bill for the More General Diffusion of Knowledge, 1779; Dewey,1916/2008; Freire, 1972; hooks, 2010). The participant researcher's desire to enable her students with the ability to engage in informed and effective debate regarding the multi-faceted issues facing our country, such as racial equity, LGBTQ rights, and gun-control, reflected a social reconstructionist view of the purpose of education (Freire, 1972). The development of argumentation skills contributes to one's ability to advocate for social change (hooks, 2010; Rugg, 1921). Therefore, this action research study involved the development of CT skills needed to generate logical, evidence-based arguments that could be used to effect social justice.

Cognitivism

Cognitivist learning theory suggested that the use of graphic organizers (Bell, 1997; Clark, R. et al., 2006; Hyerle & Yeager, 2007; Suthers, 2014), direct instruction (Engelmann & Carnine, 1982; Gagné, 1992; Hollingsworth & Ybarra, 2009; Hunter, 1982), guided practice (Ericsson et al., 1993; Magliaro et al., 2005; Rosenshine, 1995) improved learning outcomes and, therefore, informed the participant researcher's decision to use guided practice in argument mapping to foster automaticity in argument analysis and construction (Ericsson, 2004, 2020a, 2020b; Gagné et al., 1992). The intervention used in this action research study addressed the cognitivist concern with gaining student attention by employing technology with an attractive and user-friendly interface, which researchers found to improve student motivation in both children and adults (Chan et al., 2016; Ciampa, 2013). Cognitivists insist that students must be

explicitly informed of learning objectives (Gagné et al., 1992). The participants in this study were informed of learning objectives in both the online and teacher-led portions of instruction throughout the intervention through a learning objectives screen at the beginning of each set of exercises in the tutorial and by direct instruction when the participant researcher informed students of the goal of skills transfer from the tutorial to the completion of common classroom assignments such as article summaries, argument evaluation, and essay writing.

In addition to the need for practice, cognitivists also emphasize the importance of accessing prior knowledge because the mind attaches new ideas to established schema (Gagné et al., 1992; Piaget, 1936/1977). Recall of prior learning was facilitated in the tutorial through the organization of content such that each lesson built upon the previous lesson. In the second half of the intervention, the analysis of full-length argumentative articles drew upon skills practiced with shorter texts in the tutorial. Guided practice was provided in the tutorial in the form of model answers that were to be used as either a method of self-assessment or as a method of instruction as students examined models, or worked solutions, to discover how they were constructed (Clark, R. et al., 2006; Paas et al., 2003). Practice was provided through ten sets of exercises in the tutorial and two week-long practice sessions with full-length article analysis and composition before the posttest. Feedback was provided through self-assessment and teacher comments during the tutorial, and through self-, peer-, and teacher- checking after each of the four full-length article analyses and the two argument composition maps required during weeks two through five of the intervention. Finally, retention and skills transfer was facilitated through the use of full-length arguments during the second half of the intervention in

which students transferred their skills from the controlled environment of the tutorial to the more authentic environment of real-world texts.

Constructivism

Constructivism emphasizes the need for individuals to construct meaning from their experiences, to see connections and implications made by the interaction of new ideas with the old (Piaget, 1936/1977). This creative interaction is particularly compatible with the process of student inquiry or research, as the analysis and synthesis of texts is the essence of meaning-making in that the process of multiple texts' interacting with the prior knowledge of the reader produces new understandings (Rosenblatt, 1994/2005). The intervention in this action research study reflected constructivist learning theory in that the use of argument mapping to visually reconstruct the relationships perceived among an author's ideas was a physical manifestation of constructivist meaning-making (Piaget 1936/1977). The intervention took the meaning-making to an even higher level of cognition when participants constructed original argument maps depicting connections they synthesized from their own ideas and from information in source documents.

While cognitivist theory inspired methods of supporting an individual's information processing, constructivism inspired methods of supporting learning socially, such as the use of partners and models to facilitate the creation of meaning (Bandura, 1971, 1986, 1995). Collaboration was employed in the form of small groups and learning partners during the practice phase of the intervention. Students were allowed to work with others to construct meaning from the arguments provided as source material for their analysis and composition maps. Modeling was provided through images of argument map solutions in the tutorial and through the participant researcher's think-aloud strategy in

which she articulated for students the thought processes used as she made meaning from source texts.

Summary

Argumentation is an essential life skill that can empower students to become active members of society who are able to advocate for change that will foster advances in social justice. The participant researcher sought to increase student engagement in the development of argumentation in the following three ways: incorporating techniques that help the brain acquire a skill, fostering the development of CT that enables a person to see connections among multiple perspectives, and equipping students with the ability to effect positive social change. Inspired by cognitive learning theory, social constructivist learning theory, and a social reconstructionist perspective on the purpose of education, the purpose of this action research study was to describe the impact of the use of guided practice in argument analysis and composition via CAAM as an intervention to improve tenth grade students' ability to analyze and compose evidence-based arguments. Though argumentation is the primary focus of the current study, research is an essential component of argumentation because it enables a person to become well-informed and equipped with valid evidence with which to support an argument or rebut a counterargument; therefore, the term research will always precede the term argumentation when both are mentioned in this study.

The intervention used Rationale CAAM software with a convenience sample of the participant researcher's 71 high school sophomores. Students were given a pretest using familiar graphic organizers and word processing software. Students then completed a computerized tutorial in critical thinking provided by the Rationale software. Students

then applied what they had learned in the tutorial to the analysis of article-length arguments and the composition of their own argument using the texts provided by the participant researcher. The intention was to increase reading comprehension in analyzing arguments, to increase familiarity with the structure of arguments, and to improve the composition of arguments by augmenting the cognitive processing of the text with a graphic organization of ideas, specifically hierarchical summarization (Dwyer et al., 2013). The use of CAAM proved beneficial in improving the comprehension and composition of arguments (analysis, synthesis, and organization), with the results of the study showing both significance (t=7.7077, crit. t=1.67, $\propto = 05$, 95% confidence level) and an appreciable effect size (d = .9147).

Glossary of Key Terms

Argument map: "An argument map is the graphical display of the structure of reasoning" (ter Berg et al., 2013, p. 68).

Argument: "An argument is a structured set of reasons or objections bearing upon some claim" (ter Berg et al., 2013, p. 68).

Computer-assisted argument mapping (CAAM): CAAM is the use of a computer program to facilitate the organization and visual coding of ideas such that the viewer is able to perceive connections that might be obscured if presented sequentially in a prose text; it is a tool that decreases cognitive load during the processing of large amounts of data by acting as an external storage site for connections already made among the data, thereby freeing working memory to be used in ascertaining further connections (Sweller, 1988; Sweller et al., 1998, 2019; ter Berg et al., 2013; Wertheimer, 1923/2012; Wigmore, 1913).

Counterargument: “A counterargument to a reason is an objection to that reason’s contention, and vice versa” and is synonymous with the term, objection (ter Berg et al., 2013, p. 70).

Dedicated practice: This type of high-quality practice denotes a state in which a person engages a task with intense focus and intent to improve under the direction of a coach who corrects mistakes as the person repeats the task to the point of mastery (Ericsson et al., 1993). Dedicated practice is a term used to denote the kind of practice required to achieve the level of expertise displayed by elite athletes and musicians. Dedicated practice differs slightly from guided practice in the required intensity of concentration, the lack of group involvement, and the intensity & immediacy of the coach’s monitoring and corrective feedback.

Evidence-based argument: Since “Evidence is anything presented in support of a claim (contention, reason, or objection)” (ter Berg et al., 2013, p. 71), an evidence-based argument is one that is presented with specific ideas that support a claim, rather than emotional appeals, logical fallacies, or superficial rhetorical devices.

Formal argument: (syn. “Evidence-based argument”) This term was used in the attitude surveys to help students differentiate between well-informed, reasoned, evidence-based arguments and the informal, conversational argumentation in which they commonly engage. Such informal argumentation often relies upon emotional appeals and rarely employs counterarguments or rebuttals (Kuhn, 1991; Losh et al., 2017).

Guided Practice: a form of scaffolded practice in which a task is modeled for a student, then attempted again in concert with the student, and then again with the student

working independently (Pearson & Gallagher, 1983; Rogoff, 1990). Guided practice is associated with DI (Engelmann & Carnine, 1982; Hollingsworth & Ybarra, 2009) and Pearson & Gallagher's (1993) Gradual Release of Responsibility (GRR) model and is theoretically supported by Vygotsky's (1978) work on the ZPD. Guided practice differs slightly from dedicated practice in that dedicated practice requires a higher level of intensity of focus; guided practice may be conducted with a group, which can preclude the level of immediate expert monitoring and correction required in dedicated practice; and guided practice is intended to move students successfully toward independent practice; whereas, dedicated practice is intended to generate an exceptional level of expertise.

CHAPTER 2

LITERATURE REVIEW

Problem of Practice and Conceptual Framework

The identified problem of practice for this action research study concerned the participant researcher's tenth grade English II research and argumentation skills. Specific skills that needed to be addressed were reading comprehension of source material, the selection and use of textual evidence, and the organization of ideas into a cogent argument. The following literature review presents the conceptual framework that informed the present action research study, social reconstructionism, cognitivism, and constructivism. The participant researcher's desire to address cognitive load and foster logical organization of ideas in writing led to the discovery of CAAM, which combines the benefits of hierarchical visual cues and reduced cognitive load. The present action research study aimed to discover the impact of the use of guided practice in argument analysis and composition via CAAM on tenth grade students' ability to analyze and compose evidence-based arguments.

Social Reconstructionism

The participant researcher's desire to foster the ability to effect positive social change through dialectic reflects social reconstructionism's view of the purpose of education and is manifested in her selection of socioscientific issues as research topics. Current events in American society present an imperative to social action. Students must

be prepared to engage in the kind of advocacy that will effect powerful and lasting change in legislation, policing, and within individuals' core beliefs.

Cognitivism

Cognitivism emphasizes the connections the brain makes between what it already knows, and the new information it encounters (Gagné et al., 1992; Piaget, 1936/1977). The brain's tendency toward discerning patterns suggests that the manner in which a person encounters new information can affect the brain's ability to process that information (Sweller, 1988; Sweller et al., 1998, 2019; Wertheimer, 1923/2012). Therefore, the participant researcher employed an intervention that was designed to incrementally build schema in logical analysis, to utilize multiple visual cues that encode meaning, such as spatial arrangement and color-coding, and to offer a means of mediating the cognitive demands placed upon the learner as he or she engaged in the multiple processes involved in argumentation (Dwyer et al., 2012; CTS, 2013; Sweller, 1988; Sweller et al., 1998, 2019).

Cognitive theory addresses not only the efficiency and effectiveness of the form or method of the input, the content to be learned, but also the attentiveness with which the brain processes the input. Ericsson's (2020; et al., 1993) concept of dedicated practice requires the student to be actively engaged mentally with a task that is to be repeated to the point of mastery under the direction of an instructor who provides instant corrective feedback (Donahue et al., 2002; van Gelder et al., 2004; van Gelder et al., 1999). Lots of argument mapping practice (LAMP), is essential to building the skill of argumentation precisely because it is not a natural skill and needs deliberate cultivation (Kuhn, 1991; Rider & Thomason, 2014). Humans' tendency toward confirmation bias is so strong that

it must be actively countered through regularly examining data counter to one's own beliefs in order to maintain a full understanding of the issue (Mercier & Sperber, 2011; Rider & Thomason, 2014; van Gelder, 2005). The brain must be provided with structured situations in which it is forced to consider multiple alternatives, alternatives that it would completely ignore or, at best, filter and dismiss in a matter of seconds during a natural conflict or decision-making event (Heglund, 2015; van Gelder, 2005). Though this action research study relied heavily upon cognitivist pedagogy to provide instruction in argument mapping, cognitivism cannot fully account for the development of the higher order CT skills that make effective argumentation possible (Ertmer & Newby, 2013).

Constructivism

Germane to the skill of argumentation is reading comprehension and CT (Dwyer et al., 2012; Mercier & Sperber, 2011). The participant researcher was concerned that a lack of comprehension of argumentative texts impeded her students' ability to understand and glean information from source texts, so she drew upon Rosenblatt's (1994/2005) transactional theory of literacy, which reflects a constructivist view of learning as it emphasizes the creation of meaning through the influence of the reader on the text and the influence of the text on the reader. As readers mature, they bring more experience to a text, which alters the interpretation of the text. Thus, meaning can be created and altered at subsequent readings. By providing experience in the logical process of organizing ideas in the tutorial, the participant researcher hoped to provide students with prior knowledge of the structure of arguments that would help students anticipate the kinds of information they would encounter within full-length argumentative articles. Rosenblatt's theory further suggests that, as meaning-making processes, reading and writing can bear a

reciprocal influence upon one another in the mind of the reader, which informed the participant researcher's use of practice in argument analysis prior to argument composition. This transfer of knowledge was not intended in the formalist tradition of simply imitating a particular surface structure, but rather in the constructivist manner of making meaning from texts that can inform future interactions with texts either as reader or writer (Rosenblatt, 1994/2005).

Eclecticism

Though constructivist ideas, such as Rosenblatt's (1994/2005) transactional theory of reading, and cognitivist ideas, such as Gagné et al.'s (1992) emphasis on direct instruction and guided practice, seemed to be at odds, scholars such as Ertmer and Newby (2013) suggested that the complexity of human learning was too great to be constrained by adherence to a single theory and advocated instead for applying aspects of various theories as appropriate to the learning context. Based upon these theories, the participant researcher sought to determine the impact of providing multiple opportunities to practice CT skills essential to argumentation, such as reading comprehension, analysis, evaluation, and synthesis, through guided practice in CAAM upon student's argumentation analysis and composition skills.

The participant researcher is aware of the negative reputation of formalist literary theory and its association with reducing a text to a mere template and judging its worth by its conformity to a standard. However, through the lens of informed eclecticism, this educator can see the practical use of an awareness of text structures without allowing that awareness to stifle creativity or subjugate sense to form. Students can become aware of the nature of a counterargument and incorporate one into his or her writing without

having to word it in a particular manner or include it at a specified position in a text. Students can use an expert text as a model without replicating it exactly in their own writing. In fact, the more exemplar texts students engage with, the more ideas they gain about possible variation, which facilitates the cognitive flexibility to not only choose an appropriate schema to bring to bear upon a text, but to assemble a schema appropriate to a particular text and context (Spiro et al., 1987). That awareness is exactly the type of transaction to which Rosenblatt (1994/2005) refers, and it is that view which informed the rubrics (see Appendices G & H) designed to evaluate student work in this study's intervention. Students were rewarded for displaying an understanding of the use and creation of counterarguments, but the manner in which that counterargument appeared was left to the students' discretion.

Importance of a Literature Review

The literature review is an important part of action research because it allows the researcher to build his or her knowledge of the topic, to avoid problems experienced by other researchers, and to gather ideas about research questions, methodology, and measurement. A review of the literature can also provide insight into implications of the research for the classroom (Mertler, 2014). Literature selection was informed by issues observed in the classroom, such as the need for methods of increasing reading comprehension, the need for methods of increasing engagement in the research process, and, finally, the need for methods of improving students' reasoning skills. Upon discovering Rationale argument mapping software, the participant researcher sought out other argument mapping scholars by consulting the annotated bibliography within the software designers' book, *Critical Thinking: Reasoning and communicating with*

Rationale (CTS, 2013; ter Berg et al., 2013). Reviewing the references cited by those scholars revealed prominent scholars in argumentation, such as Kuhn (1991), van Gelder (2001), Buckingham Shum (2003), and Harrell (2004).The databases used in the literature search were Academic Search Complete, Dissertations and Theses, Education Source, ERIC, PsycINFO, Google Scholar, JSTOR, and Sage Reference Online. Peer-reviewed, original studies were preferred, but trade books, reference books, and conference papers were also consulted. Though it is not cited from directly, Newell et al.'s (2011) literature review on the teaching of argumentation was another helpful source of scholars' names and important studies.

This review begins with a discussion of critical thinking (CT), of which argumentation is one aspect. The method of direct instruction (DI) is then explored, with particular emphasis on the aspects of DI having the greatest bearing upon this study's intervention, the nature of practice, the scaffold of modeling, and the Gradual Release of Responsibility model (Pearson & Gallagher, 1983) of presenting material that utilizes repeated practice, and modeling to support learners. The cognitivist aspects of graphic organizers is then explored in preparation for a discussion of their use in argumentation instruction. The argumentation section of this review begins with the history of argumentation as a topic of study and moves to a discussion of its relevance in the 21st century classroom. The processes of argumentation are discussed, as well as the information seeking process (ISP), which is an essential part of generating evidence-based arguments. A discussion of difficulties common to both children and adults when engaging in argumentation serves to emphasize the need for direct instruction in argumentation in the K-12 classroom. The review of argumentation literature ends with a

discussion of CAAM and its use in the secondary classroom as a means of facilitating the development of argumentation skills.

Critical Thinking (CT)

Because of his ability to bring his knowledge of education, philosophy, and psychology to bear upon his thoughts on CT, Dewey (1910) is credited with the modern concern for CT in education, though its use in education can be traced to Socrates' method of questioning his students' answers in order to engage them in reflective thinking (Hitchcock, 2018). There are myriad definitions of CT that emphasize different aspects of the process (Marsh, 2013), but Facione's (2020) is both lyrical and succinct, "Critical thinking is skeptical without being cynical. It is open-minded without being wishy-washy. It is analytical without being nitpicky. Critical thinking can be decisive without being stubborn, evaluate without being judgmental, and forceful without being opinionated" (p. 25). CT is often defined by the cognitive processes associated with reasoning—Halpern (1998) provides a concise list of categories, such as verbal reasoning, argument analysis, hypothesis testing, discerning probability, and decision-making—but scholars are now also emphasizing the development of the dispositions that predispose a person to utilize those cognitive processes regularly, such as (Facione, 2020; Halpern, 1998; hooks, 2010). Facione's (2020) definition of critical thinking alludes, by negation, to those positive dispositions. For example, Facione (2020) mentions that the critical thinker is not wishy-washy, implying that he or she is confident in logic and in his or her own knowledge and abilities. The critical thinker is not nitpicky because he or she can see the larger scope of an issue and will not waste analytical effort on insignificant aspects of an issue.

The American Philosophical Association's 1990 Delphi consensus on critical thinking dispositions names aspects of intellectual integrity, such as fair-mindedness, honesty in recognizing personal bais, open-mindedness, being systematically analytical, and tending to reserve judgement until adequate evidence has been considered (Facione, 1990). Facione and Facione (1992) noted that while it is important to name the CT virtues, it is equally important to name its vices, for they are what must be dislodged before the virtues can take hold. Inattentiveness, indifference, and haphazardness are all too common among the participant researcher's students, but perhaps more insidious is the propensity to utilize CT skills to take advantage by misleading others with sophistry. Such has been a source of the mistrust of rhetoric since the fifth century BCE and is a current source of the plague of fake news.

Halpern (1998) suggests a method of teaching CT that begins with the purposeful cultivation of those virtuous dispositions rather than omitting them as non-academic matters and attending solely to skills. Halpern also emphasizes the need to provide or explicitly draw attention to opportunities for utilizing CT or for displaying CT dispositions so that students will begin to see those opportunities for themselves. The essential nature of CT dispositions is made clear in nursing education. Since nurses are expected to make important decisions about others' health, sometimes under extreme stress, it is important that they have both the skill to arrive at a logical conclusion, and the dispositions that will facilitate that deliberation under pressure (Facione & Facione, 1996). Glaser's (1941) work provides some optimism in that the disposition of willingness to engage intellectually was able to be improved and that students showed evidence of transferring intellectual curiosity, what Glaser calls wanting evidence for

beliefs, to situations beyond classroom assignments. Suggestions for fostering awareness of the CT dispositions appear in the Implications for Practice section of Chapter 5 of this dissertation.

Argument is only one aspect of CT. Yet, it is often the method of CT instruction, particularly since the advent of an emphasis upon argumentation ability in state and national education standards and high-stakes tests (ACT, 2016; College Board, 2016; National Governors Association Center for Best Practices and Council of Chief State School Officers, 2010; South Carolina Department of Education, 2015). Perhaps the argumentation aspect of CT is emphasized because it requires the use of multiple CT skills, such as interpretation, analysis, synthesis, and evaluation, and because evidence of CT is easier to assess via argumentation than through other forms of problem solving. If you ask a student to solve a complex, ill-defined problem, the answer may not reveal the processes used to arrive at it. For example, the problem is getting goods from one side of a river to the other. Brainstormed options are to use a boat, travel upstream to find an easier crossing point, or build a bridge. The chosen answer does not reveal how the student came to that decision, which, hypothetically, may not have involved CT at all. Furthermore, any of those answers could be the best choice depending upon the situation, which would require argumentation to justify it as the best choice. Whereas, with argumentation, evidence of those mental tasks is displayed explicitly within the argument itself. If an argument contains reasons for and against a contention, there is evidence of analysis. If a point in a counterargument is conceded, but the remainder rebutted, there is evidence of synthesis and evaluation in that common ground has been acknowledged

among the perspectives of an issue, and one valid idea has been preferred over another valid idea.

Just as there is a wide variety of CT definitions, there is a wide variety of CT assessment instruments. Standardized tests, such as the California Critical Thinking Skills Test assess one's ability to recognize logical conclusions, logical fallacies, or extraneous detail (Ennis & Chattin, 2018; Facione, 2020; Marsh, 2013). Standardized tests, while convenient, are not a readily available alternative for individual classroom teachers due to financial and logistical considerations. Written tests assess one's knowledge of and facility with the elements of argumentation, such as the International Critical Thinking Essay Test (n.d.), which asks test takers to analyze the elements of an argument, then write a critical evaluation of it. Some tests combine multiple choice and short written response question types, such as the Halpern Critical Thinking Assessment (Marin & Halpern, 2011). Other measures of argumentation use the presence of surface elements to indicate the critical thinking processes the test-taker engaged in while composing an argument, such as the number of verbal markers indicative of a premise or a rebuttal (Bacig et al., 1991), while others assess a student's ability to label portions of a prose text with the argument element it represents (Butchart et al., 2009). Argument mapping, however, offers practical advantages over prose assessments.

Prose composition can be a confounding variable in assessing CT skill because of differences among students' writing ability, specifically the way in which the student verbalizes the connections among his or her ideas. With an essay, the grader must mentally reconstruct the writer's argument, which can be time-consuming and could produce inconsistent assessments of CT skill depending upon the student's level of

writing ability. Whereas, with an argument map, the grader does not have to reconstruct anything because the reasoning is explicit. If CT skill is what is being assessed, an argument map can produce a more valid result because the student's writing ability has less of an opportunity (admittedly, one must write the ideas that fill the map) to obscure his or her reasoning process.

This is not to discount the need to instruct students in prose composition, but rather to suggest that an argument map is a better place to assess CT than prose, and an essay is a better place to assess writing ability than an argument map. Separating the two processes, argument generation and prose composition, serves as what Leckie (1996) calls stratified methodology in which cognitive processing is enhanced by the reduction of cognitive load. Facione & Facione's (1994/2011) Holistic Critical Thinking Scoring Rubric (Appendix I) provides an easy to use rubric that could be used to assess CT in map or prose form. Even if one intends to assess the prose only for writing skill, one would want to reevaluate the expression of an argument as it is translated from map form to prose to ensure that logic and clarity have been maintained, which is the essence of writing—to communicate clearly. Using the same rubric for both products could provide a reassuring continuity for students as they transition from graphic representation to prose representation.

Direct Instruction (DI)

DI is a teacher-centered method of instruction based in cognitivism that emphasizes the systematic presentation of material to effect learning, retention, and transfer of the information or skills (Engelmann & Carnine, 1982; Hollingsworth & Ybarra, 2009). Gagné's (1992) Nine Events of Instruction propose a sequence of teaching

moves designed to efficiently and effectively cause students to learn by directing their thoughts and actions throughout the acquisition so as to minimize error. The stages or steps are called events to emphasize the fact that they are actions the teacher performs. The first three events set the stage for learning. The first event is reception during which the teacher gains students' attention. This can be achieved through the use of high-interest material or novelty. The second stage is expectancy during which the teacher informs the students of the skill or material they will master through the lesson. The third event is retrieval during which the teacher prompts students to recall relevant prior learning to ready the student's brain to associate the new information with old schema.

The fourth and fifth events deal with the presentation of the material to be learned. The fourth event is selective perception during which the teacher incrementally exposes students to the new information. This event is called selective perception because the teacher selects small portions of the material to expose students to and organizes the portions logically to facilitate understanding. The fifth event is semantic encoding during which the teacher provides methods to aid memorization or acquisition of the new information. This event can be achieved through sharing nonverbal presentations, concept maps, mnemonics, or by alerting students to common errors (Gagné, 1992).

The final four events deal with practice and assessment. The sixth event is responding during which the teacher provides the student with a task that requires use of the new information. There are several types of practice that will be discussed at length in the next section of this review. The seventh event reinforcement during which the teacher provides feedback to let the students know how well they are mastering the material. The feedback at this point in the lesson should focus upon the positive to reinforce appropriate

student actions and to foster feelings of self-efficacy. The eighth event is retrieval during which the teacher tests the students to see whether they have mastered the material. This event could involve formative or summative assessment. If formative, further practice would follow before administering a summative assessment. The ninth event is generalization during which the teacher provides spaced reinforcement of the material through further practice or extension activities that help the students to see how the information or skill applies to situations beyond the specifics of the lesson (Gagné, 1992).

There are many models of DI, such as Engelmann & Carnine's (1982) foundations of direct instruction, Hunter's (1982) Mastery Teaching, Rosenshine's (1995) cognitive strategies and guided practice, and Hollingsworth & Ybarra's (2009) Explicit Direct Instruction (EDI). These disparate models share many traits with Gagné's (1992) Nine Events of Instruction, such as explicitly stating learning objectives, accessing prior knowledge, presenting instruction in small portions arranged in increasing complexity, practice, feedback, and assessment. Three of those common traits particularly relevant to the current study are the use of practice, modeling, and incremental instruction.

Practice

Ericsson's (2004; 2020a, 2020b; et al., 1993, 1994) work on the cultivation of expertise reveals that not all forms of practice produce equivalent gains. Mere repetition without corrective feedback can further ingrain mistakes or misunderstandings. Repetition in which students recognize their errors, but do not know what needs to be done to improve their performance, fails to produce gains. Structured practice in which a teacher designs the practice task, but does not provide feedback during practice or

focused practice in which a student engages in mentally attentive practice of their own design without input from an instructor do produce gains (Ericsson, 2020a & b). However, Ericsson (2020a & b; et al.,1993) emphasizes that it is only dedicated practice, that raises performance to expert levels. Ericsson's work began with sports expertise, but has since been applied to music instruction as well. Dedicated practice requires the student to focus intensely, repeating the task or skill to the point of mastery under the supervision of a coach who provides instantaneous feedback and correction. This kind of practice is difficult to translate to the academic classroom, but van Gelder et al. (2004) suggests that CAAM can better approximate dedicated practice than traditional prose instruction due to the instantaneous feedback provided by the model answers, the volume of guided practice provided in the tutorials, and the time-saving efficiency of producing computerized maps as opposed to paper and pencil maps or prose.

Guided practice, like DI, has many faces, but they all build on Vygotsky's (1978) social-constructivist concepts of the *zone of proximal development* (ZPD) and the *more knowledgeable other* (MKO), which hold that students can learn best when faced with a goal that is just a bit too difficult to achieve without support from an expert, or MKO. Rogoff's (1990) Apprenticeship, Guided Participation, and Participatory Appropriation model emphasizes social interactions among learners and instructors but does not prescribe the roles or actions of the persons involved. For example, someone could learn by watching an MKO without the MKO's even being aware that he or she is providing instruction. Students could expand their own understanding by simply listening to the questions or statements made by others in the environment, not necessarily their own group members, a sort of ambient learning. Rogoff's (1990) model would even be

compatible with Paas et al.'s (2003) worked solutions model, with the MKO being simply the visual image of the step-by-step presentation and explanation of the solution. The guided practice phase of Hollingsworth and Ybarra's (2009) EDI model emphasizes the apprenticeship aspect with the teacher working problems with students step-by-step either in a whole-group or an individual setting. In guided practice, whether the MKO is a peer or an expert, they provide support through modeling. Magliaro et al., 2005 suggests that even computerized tutorials can provide a guided practice environment (see Butchart et al., 2009) if it provides interactive feedback, such as explanations of why answers are correct or incorrect.

Modeling

Combining the effects of cognitivism and constructivism, Bandura's (1986) social cognitive theory informed the use of modeling as an instructional method because it melds an efficient method of transmission with the constructivist concern for the social creation of meaning. Expert models or MKOs can be adults, peers, or even texts as in the case of Paas et al.'s (2003) worked solutions model. Bandura (1971) found that peers can be even more effective models than expert adults because children can more easily believe in their own ability to accomplish a task when they see a peer be successful, than they can by seeing an expert be successful. The intervention for the present study utilized multiple forms of modeling, expert modeling when the participant researcher modeled the process of constructing a researched argument, peer modeling when students worked together during the tutorial and the applied practice portions of the intervention, and textual models when the Rationale tutorial provided worked solutions for students to study or to use to self-assess their work.

Gradual Release of Responsibility (GRR)

Pearson and Gallagher's (1983) GRR instructional model combines the selective perception, guided practice, and modeling aspects of DI (Engelmann & Carnine, 1982; Gagné, 1992; Hollingsworth & Ybarra, 2009; Rosenshine, 1995) with the social aspects of Vygotsky's (1978) social-constructivist learning theory. The GRR model provides incremental instruction that is organized purposefully to enable students to acquire information efficiently and effectively. Students' efforts are scaffolded by experts' and peers' modeling and interactions. With GRR, the instructor models a process to a whole group through a think-aloud presentation that makes the hidden mental processes explicit. Then, students repeat the process with peers, articulating their thought processes along the way and supported by the instructor's feedback. Finally, the individual student attempts the task unaided by others, but continues to receive feedback. The present study utilized the GRR through the use of guided practice in the form of access to annotated answer keys, which could also be used as worked solutions, during the tutorial, expert think-aloud modeling presentations before the application practice portion of the intervention, peer modeling and interaction during the application practice portion of the intervention, tapering off to individual work on the posttest.

Graphic Organizers

The use of graphic organizers combines cognitivist concerns with cognitive processing and constructivist concerns with scaffolding students to achieve a ZPD (Ausubel, 1963; Gagné, 1992; Vygotsky, 1978). Graphic organizers facilitate cognitive processing through gestalt processes of visual perception. Viewers can infer non-verbally expressed connections among ideas by noting visual cues, such as proximity, similarity,

continuation, etc. (Wertheimer, 1923/2012). Therefore, graphic organizers are extremely useful in facilitating comprehension (Dwyer, 2012; Haller, 2010; Halpern, 2003; Harrell, 2005a & b; Hyerle & Yeager, 2007). The brain's tendency toward dual coding (Paivio, 2014), enables complex relationships to be more easily communicated and perceived via the graphical cues of argument maps than prose texts. Because of the synergistic effect of combining imagen (graphic) and logogen (words), the perception of ideas in an argument map requires less working memory, thereby reducing cognitive load (Paivio, 2014). While there may be a learning curve in creating argument maps, learning a type of non-verbal language, the visual cues in Rationale argument maps draw upon gestalt principles of proximity (position), similarity (color), and continuation (the connections linking lines of thought) (Wertheimer, 1923/2012), thereby facilitating the quick and effective reading of Rationale argument maps.

Historical Context of Instruction in Argumentation

In the classical rhetoric of ancient Greece and Rome and continuing into the 17th century, rhetoric and poetics enjoyed a relatively balanced position in education. Both were concerned with expressing a society's moral worldview. While poetics expressed that worldview through aesthetic means, rhetoric provided the means to make manifest that worldview in practical social action. The ancient classics exhibited both traits, but in the 18th century, the influence of the epistemology of the scientific method, and later 19th century positivism, constrained the role of rhetoric to empirical logic and, thus, to objective texts devoid of any form of metaphysical, or even ethical, contemplation (Berlin, 1985). Rhetoric had become the domain of composition, and poetics the more esteemed domain of literature (Berlin, 1985). Widely used in college composition classes

from 1800-1850, George Campbell's (1776/1868) *Philosophy of Rhetoric* reflected Newtonian inductive logic in which truth was determined by scientific observation of the rational universe, rather than the deductive manner of Aristotelian rhetoric, judging truth by its ability to conform to the rules of logic (Berlin, 1982). Since empirical truth could not be invented, the writer could concern himself only with the arrangement and style with which he presented truth, thus narrowing the scope of rhetoric (Berlin, 1982). While the 18th century valued oration, the 19th century preferred written discourse (Berlin, 1985), leading to the preeminence of Blair's (1783) *Lectures on Rhetoric and Belles Lettres from 1783-1911*. Blair (1783) revived the idea that rhetoric and poetics are connected in that the study of poetics teaches students to write, or generate ideas, and the study of rhetoric teaches, via the imitation of model texts (i.e. poetics), the presentation of those ideas in logical, empirical arguments. However, the emphasis on empirical logic denied the validity of plurality, thereby denying the validity of persuasive discourse even on ethical issues, which Berlin (1985) suggested led to the decline of open debate and the social change it could affect.

In reaction to empirical logic of positivist epistemology and the current-traditionalist emphasis on style over content, neo-Platonist epistemology and expressionist literary theory of the late 19th century insisted that rhetoric is the method by which truth is constructed (Berlin, 1984). Murray (1970) suggested that one can learn writing, but it cannot be taught. With such a stark outlook, one wonders why anyone would bother trying to write, but there is a quite a good reason, and it has not to do with writing, but rather with thinking. One writes to discover his or her own perceived truth. Though Expressionists insist that language can never truly represent truth, analogy can

approximate the individual's vision. Dialogue with others is used, not to facilitate the audience's understanding of the writer's truth, but to aid the writer in expressing more exactly his or her vision of truth. In both the Positivist and Neo-Platonist schools of rhetoric, knowledge is permanent and located in a specific place, reason, perception, or the individual as a whole. However, the new rhetoric of the 20th century conceived of truth as dynamic, constructed via the interactions among the writer, the audience, reality, and language. In this way, the new rhetoric addressed all the aspects of writing: "invention, arrangement, and style" (Berlin, 1982, p. 776). Thus, we see the movement from epistemological rhetoric in which incontrovertible truth is presented via logic, through the isolated subjective truth of the individualistic Expressionists, to hermeneutic rhetoric in which truth is created, temporarily, via a dialogue among the speaker, the audience, the subject, and the context (Berlin, 1982). The implications for contemporary pedagogy include the necessity of creating an atmosphere of dialogue and discovery prior to complex argument research activities in order for students to understand the amount of exploration necessary to create a good argument (Nystrand & Graff, 2001).

Brent (2013) argued that writing from sources—a less intimidating term for producing a researched text—should be central to the curriculum and agrees with Gyenes and Wilks (2014) that argumentative essay writing hones decision-making and meaning-making skills necessary for success in both the workforce and academia. Bregant (2014) argued for the development of argumentation skills as necessary for democracy. Without the ability to consider multiple points-of-view and to recognize errors in reasoning, students will not be prepared to engage in important decision-making on issues of social justice. However, DeStigter (2015) purported that argumentation as a means to personal

and societal prosperity is nothing more than a romantic ideal in view of imbalances of power that preclude many members of society from engaging in debate among equals and in view of the dismal economic outlook for the college-graduate and the non-graduate alike. DeStigter (2015) suggested that the overemphasis of argumentative writing limits the type of thought considered to be socially valid because of the either-or stance common to debate and evident in political ideology's ascendancy over logical arguments. However, teaching argumentation as a multifaceted dialogue can eliminate that dogmatic tendency (Fletcher, J. 2015).

Information Seeking as a Process

One of the most influential pedagogues in the area of the research process is Kuhlthau (1988) who articulated the six-stage mental and emotional process in which researchers engage, the Information Search Process (ISP). Kuhlthau's (1988) attention to the emotional aspects of this cognitive task mirrors the dispositions associated with CT (Facione, 1990), such as the need for self-efficacy and persistence. The task of the first stage of Kuhlthau's (1988) ISP, initiation, is to recognize the need for information prompted by the teacher's assignment. Feelings of anxiety and a lack of confidence are associated with initiation. The second stage, selection, is met with optimism as the researcher identifies a topic. McKenna and McKenna (2000) suggested that the knowledge necessary to write coherently about a topic comes from three sources, prior knowledge, observation of one's daily world, and from published sources. Students who choose topics often do so without regard to their accessible knowledge base. Therefore, McKenna and McKenna (2000) suggested that teachers direct topic selection by limiting topics to those with which students have a daily interaction, such as family, consumerism,

entertainment, leisure, and locale. The third stage, exploration, is the stage most often omitted by researchers though it is arguably second in importance only to the sixth stage, presentation. The exploration stage is essential because it is during this time that the researcher gains a broader knowledge of his or her topic.

During the first three stages, the researcher's thoughts are vague, which can cause anxiety for some due to the length of the exploration stage. It is disconcerting to students to have read multiple texts without having taken notes, but it is not yet the time for specific note-taking because the researcher does not yet know what he or she wants to prove; therefore, the notes taken would be random, relatively unrelated facts unlikely to support a single thesis. Exploring the breadth of a topic provides opportunities to see connections among different aspects of the topic thereby providing the focus necessary to transition from a general topic to a specific stance, at which point confidence rises (Kuhlthau, 1995).

Clarity of thought is characteristic of the fourth stage, formulation, in which the researcher formulates his or her personal stance or thesis. The researcher's interest is piqued at this point, leading to fruitful data collection, which is the fifth stage of the information search process. Students often spend large amounts of time on this stage because they perform the task of note-taking too early to know what they are looking for. With a focused stance, data collection becomes an efficient process with a definite end. Whereas note-taking performed during the exploration stage leaves the researcher wondering whether he or she has enough material, note-taking after the formulation stage provides a clear end to data collection. At this point, the researcher can be confident that he or she has enough material when he or she can fully defend his or her thesis, but it is

not enough to simply collect data. Sormunen and Lehtiö (2011) suggested that the researcher must also begin sorting his or her notes according to the connections among them. This process will facilitate final stage of Kuhlthau's (1991) ISP.

Presentation, the sixth stage of Kuhlthau's (1991) ISP, is the time during which the researcher prepares to share his or her findings. In this stage, the researcher is engaged in generating statements that explain the connections among his or her facts and their significance in supporting the thesis. At this point, the researcher is also concerned with the physical design of the chosen mode of presentation, which could be an essay, a speech, or a multimedia presentation. Since multimodal, or multimedia, compositions allow students to learn and convey information via all six English language arts modalities, reading, writing, speaking, listening, viewing, and visually representing, both the authors and the audience are able to better internalize the subject matter presented (Dalton, 2012; Dickson et al., 2002; Slack, 2001). It would seem to be a given that students' research assignments should impart not just an understanding of a research and/or a publishing process, but also significant knowledge that enriches both the author and the audience. However, very often, students' topics are secondary to the generation of the end product. Ensuring that students select topics that they perceive to be meaningful and relevant will foster their engagement throughout the process and lend validity to the assignment and the process of information seeking (Kuhlthau, 1988, 1994; McKenna & McKenna, 2000).

At completion, if the researcher has been successful, he or she experiences relief or satisfaction (Kuhlthau, 1988). If, however, the researcher has been unsuccessful, disappointment sets in. To help prevent that disappointment, familiarity with what

constitutes an acceptable final product is necessary. Lu and Zhang (2013) found that students who regularly engaged in peer evaluation using rubrics were better able to produce stronger arguments. Students complete peer evaluations, after which, the teacher shares her evaluation. A high rate of agreement with the teacher's evaluation of their peers was a good predictor of a student's own success in writing arguments.

It is important to note that the ISP is such an individualized process that students will be in the same stage at the same time only in the first and last stages of the process (Kuhlthau, 1995). Kuhlthau (1988) suggested that traditional instruction in generating research papers does not consider the constructive mental process of making meaning in which students are engaged during research, nor does it take into consideration the range of emotions experienced by the student throughout the process. Sharing Kuhlthau's (1991) framework with students prior to research activity may alleviate some fear and frustration by validating the negative emotions that may arise and showing students that those emotions will pass as they engage in the process.

Common Difficulties with Research and Argumentation

The literature reveals that adults suffer from the same problems that children deal with in composing arguments and writing from sources, for example, evaluating the validity of source material, doubting the validity of their own knowledge compared to an authoritative source, or knowing when to cite (Haller, 2010; Kuhlthau, 1991; Kuhn, 1991; Vieyra et al., 2013). Kuhn's (1991) influential work, *The Skills of Argument*, describes her study of the reasoning ability of a cross-section of Americans representing the spectrum of ages and education levels. Kuhn (1991) established that the vast majority of the population is unable to generate a supported argument that even considers alternative

views, much less convincingly rebuts a valid counterargument. She further established that while well-reasoned argumentation is not a natural skill, it can be learned and taught. However, the several processes occurring simultaneously in the construction of arguments, such as reading comprehension, the evaluation of the validity of sources, weighing the merits of various points-of-view, and generating one's own beliefs can overwhelm the novice researcher/writer. Instructors can mitigate cognitive overload by scaffolding or removing some of the cognitive burden associated with such complex processes (Bacig et al., 1991; Gagné et al., 1992; Leckie, 1996). Monte-Sano et al. (2015) insist that explicit modeling using Pearson and Gallagher's (1983) GRR instructional model is essential for managing the cognitive burden associated with the multiple skills used in writing from sources. Other researchers suggest the use of stratified methodology, which is another way of mitigating cognitive load by introducing a process stage-by-stage rather than in its entirety (Brent, 2013; Nelson & Hayes, 1988; Kuhlthau, 1988, 1991, 1995; Leckie, 1996). It is important for instructors to remember that the point of instruction is learning and growth, not just the generation of a perfect product at the end of a unit (Brent, 2013). When students stretch the limits of their ability, they can easily miss the mark. Punishing error in such an instance stifles the urge to grow.

A lack of reading comprehension of source material is another issue that affects the argumentation ability in students at all levels. Vieyra et al. (2013) found that the reader's lack of comprehension of the source material led to instances of plagiarism, even at the graduate level. The most common problem among students at the collegiate level is patch-writing in which a student combines his or her writing with significant portions of appropriated text both with and without appropriate documentation (Shi, 2010; Vieyra et

al., 2013; Schwabl et al., 2013). Ku et al., (2014) found that undergraduate students were less likely to generate counterarguments when presented with authoritative information because they lacked the confidence to question expert source texts. Alverman (2003) found that self-efficacy is a significant factor in secondary students' willingness and ability to engage in the processes of close reading and argumentation. This common thread of the impact of a lack of reading comprehension suggests that people of any age are apt to doubt their own knowledge in the face of perceived experts. Therefore, especially with secondary students, instructors must provide the scaffolding necessary for students to feel that they are able to engage in academic tasks. Such scaffolding does not require making the assignment less rigorous, but rather it requires instructors to allow students to use texts that they find less intimidating (Alverman, 2003).

The Need for Practice in Argumentation

Due to time constraints within the classroom and the labor-intensive nature of formal research projects, the research paper assignment is often a once-and-done task that does not provide adequate practice to facilitate the acquisition of the required skills (Artman et al., 2010). Even the synonymous appellation, term paper, suggests that it is a task competed only once within a course. However, Brent (2013) suggests that writing from sources, a more contemporary term for the task associated with composing research papers, involves the development of CT skills as much as the development of reading and writing skills. Without multiple opportunities to practice the demanding skills of source analysis, source synthesis, and supporting claims with evidence, students cannot be expected to achieve significant and lasting growth from one term to another (Artman, et al., 2010; Brent, 2013).

Though high schools continue faithfully to teach the traditional research paper, Hood's (2010) survey of college freshman composition courses reveals that only 6% of freshman composition classes continue to assign the traditional research paper, preferring instead alternative research assignments, the most popular of which is the researched argument (Strickland, 2004; Wissinger & De La Paz, 2016). New methods of presentation are gaining favor as well, such as the multimodal presentation in which multiple texts representing different modes of writing are generated from the information gleaned from research (Dalton, 2012; Dickson et al., 2002; Slack, 2001; Strickland, 2004). A higher volume of such alternative assignments can help to provide the volume of opportunities for high-quality practice necessary for skills improvement.

Computer-Assisted Argument Mapping (CAAM)

In the early 20th century, lawyer and legal scholar John Henry Wigmore (1913) developed a method of visually representing the connections among ideas in complex court cases to facilitate comprehension of such large amounts of information. In essence, Wigmore's paper charts functioned as external working memory to mitigate cognitive load, thereby, allowing members of the court to attend to the higher cognitive process of evaluating the case, while the argument map held and visually symbolized the vast amount of analysis and synthesis already conducted. Wigmore's evidence charts continue to be used in law classrooms today (Buckingham Shum, 2003).

Applying cognitive theory to Kuhn's (1991, 2006) contention that argumentation can be taught, van Gelder (2001, 2002, 2005, & 2015) has contributed significantly to the field of CT and the development of argumentation skills, particularly through the development of argument mapping software. van Gelder's work on the development of

argumentation skills provides quite a practical model for practitioner researchers in the classroom (van Gelder, 2015). The present study employed one of van Gelder's (2001, 2015) instructional methods, presenting participants with multiple arguments representing opposing sides of an issue and asking them to analyze and evaluate the strength of the arguments, then having participants generate their own arguments using argumentative source material.

Because this action research study employed Rationale CAAM software as its intervention, relying upon its co-developer van Gelder's (2001, 2002, 2005, & 2015) findings, and those of his former student, Alvarez-Ortiz (2007), presented a conflict of interest and the potential for circular reasoning: It works because the developer says it does (CTS, 2013). However, it would be remiss to omit van Gelder's (2001, 2002, 2005, & 2015) work completely. Twardy (2004), conducted an experiment to test for founder's effect on a study by Donahue et al. (2002), but found that his results were only slightly lower than theirs with a Cohen's *d* effect size of .72 and .8 respectively, which is significantly higher than the .3 effect size achieved by a year of university study. Furthermore, the format of Twardy's (2004) measurement instrument, the California Critical Thinking Skills Test, was quite different from the format of the argument maps created via CAAM, which supports the idea that gains were due to an internalization of CT skill, rather than participants' simply becoming adept at the process of creating argument maps. However, Twardy (2004) acknowledged the limitations of not having a truly random sample and completely controlled study context.

Butchart et al. (2009), reported that participants showed an improvement in CT skills as a result of CAAM. The software used was a Java applet that is not available to

the public. Therefore, the participant researcher was unable to test the product herself. While it did provide students with automated feedback, that feedback was limited to recognizing the similarity of student-selected textual evidence to facilitator-selected evidence as examples of claims, counterarguments, rebuttals, etc. Such feedback discourages the development of summarizing and paraphrasing skills and precludes elaboration on hidden premises or warrants, which is counter-productive to my desire to increase reading comprehension, a skill which can be developed and displayed through skillful summaries and paraphrases (Dwyer et al., 2012). Rationale's model answer format of feedback was chosen for this study because it allows students to self-evaluate, and teacher checking assures that student's errors are brought to their attention (CTS, 2013).

The current study utilized a measurement instrument similar to the one used by Osborne et al. (2004) to evaluate argument composition. The instrument has been cited by Zohar and Nemet (2002) and Hasnunidah et al. (2015) as providing an efficient means of data collection. The Osborne et al. (2004) rubric contains five levels that begin with the presence of a claim versus another claim or counterclaim and adds elements progressively (evidence, counterarguments, rebuttals) until the ultimate level, five, contains an "extended argument with more than one rebuttal" (Osborne et al., 2004). The composition rubric used in the present study (see Appendix H) consists of four levels that begin with level zero, indicating the absence of an element, and adds elements progressively until the ultimate level, three, contains the same criteria as level four of the Osborne et al. (2004) rubric, a claim, a counterargument, and a clear rebuttal. The present study required participants to reconstruct authors' arguments to scaffold reading

comprehension, in addition to providing models for argument structure (Dwyer et al., 2012). By forcing students to conduct a close reading of the text in search of argument elements, participants would be more likely to comprehend the text better, which would facilitate the selection of relevant evidence upon argument construction (Verlaan et al., 2014). The argument analysis rubric (see Appendix G) contained the same elements as the argument composition rubric (see Appendix H); however, the successive levels of performance were determined by the percentage of the author's argument accurately reconstructed.

Harrell's (2005b) review of argument mapping software and her website, *iLogos* (Harrell, n.d.b), which contains an annotated catalog of available argument mapping software programs, was instrumental researching the best product for the present study's intervention. Her own program, iLogos (Harrell, n.d.a), is quite intuitive, flexible, and open source (free). However, it is not as aesthetically pleasing as Rationale and, more importantly, iLogos does not provide the interactive tutorials that Rationale does (CTS, 2013; Harrell, n.d.a). A desire for students to work at their own pace required blended instruction in which students could access instruction online, with the teacher being free to facilitate and address individuals' questions. This need seemed best met by Rationale's tutorial, which provided the majority of the instruction in CT and argument structure in the present study's intervention (CTS, 2013).

While there were several studies that addressed the use of argument mapping to improve reasoning in philosophy or CT skills classes (Butchart et al., 2009; Harrell, 2004, 2005, 2011, 2012; McGuire, 2010; Twardy, 2004), science classes (Bell, 1997; Heglund, 2015; Lapp et al., 2013; Monahan, 2013; Nussbaum, & Schraw, 2007; Swanson

et al., 2014; van Bruggen et al., 2003), business classes (Carrington et al., 2011; Kunsch et al., 2014), medical classes (Carwie, 2009; Santiago, 2011), and history classes (Buehl et al., 2014), there were very few that addressed its use in the language arts classroom (Bacig et al., 1991; Newell et al., 2011; Nussbaum, 2008; Maftoon et al., 2014) only one of which was conducted with secondary students. It was my hope that the present study could help to provide fellow secondary language arts practitioners insight into why instruction in argumentation and CT is essential and to offer ways to incorporate it throughout the curriculum in the volume necessary to effect lasting improvement. The present study also provides a rigorous alternative to the traditional prose assignment, an alternative that can be used as an accommodation in differentiated instruction.

Summary

When rhetoric concerned itself with both invention and arrangement, as it did in the classical Aristotelian tradition, it was viewed as a powerful source of truth and logic, but when it devolved into mere ornamentation of empirical fact, as it did in the 18th century, it came to be viewed with suspicion as the hollow veiling of spurious arguments with a grammatically precise veneer. However, with the advent of an epistemology that embraces the dynamic, socially constructed nature of truth, the new rhetoric of the 20th century reclaimed its ability to move men to action through the generation of arguments that contain both substance and grace (Berlin, 1982, 1985). Though current political speeches rarely exhibit the level of evidence-based argument the public needs in order to make informed decisions, there remains an expectation that decisions be informed by both data and ethics. In this way is rhetoric essential to democracy. Argumentation is a valuable tool that facilitates the very essence of social reconstructivism, which is to

generate a socially just transformation of society. Therefore, it is essential to train students in argumentation.

However, argumentation is not a natural ability (Harrell, 2011; Kuhn, 1991; Wertheimer 1923/2012). Because argumentation incorporates many cognitive processes in the creation of meaning, it has proven to be a challenge to both students and adults. Eclecticism in pedagogy allows teachers to choose the best match between task and technique. Both cognitivist and constructivist pedagogy offer strategies to facilitate the development of argumentation skills. Cognitivism provides strategies such as graphic organizers and visual cues that mitigate cognitive load as students navigate multiple texts and perspectives in their search for information and enable the brain to consider large amounts of information and the connections among them (Anderson & Pearson, 1984/2002; Bell, P. 1997; Clark, R. et al., 2006; Hyerle & Yeager, 2007; Spiro et al., 1987; Suthers, 2014; Wigmore, 2013; Wertheimer 1923/2012). Constructivism provides the understanding that knowledge is constructed within the individual in concert with others, which can be facilitated by a dialectic approach that encourages questioning and interaction with peers (Bandura, 1986; Felton & Kuhn, 2001; Vygotsky, 1978).

Honing the skill of argumentation requires guidance and practice. With the advent of the Common Core State Standards and its emphasis on CT and argumentation in K12 education (National Governors Association Center for Best Practices and Council of Chief State School Officers, 2010), scholars have attempted to increase CT skills through a high volume of guided practice in argument analysis, evaluation, and composition in an online environment (Butchart, et al., 2009; Dwyer et al., 2012; van Gelder, 2005). CAAM is a tool that combines the best of cognitive support and collaboration in the generation of

arguments. CAAM offers a means of organizing information such that connections among ideas are communicated nonverbally using spatial organization and the use of color, thereby freeing up working memory to consider more abstract concepts such as anticipating counterarguments (Wertheimer 1923/2012). Argument mapping allows one to consider an argument in its entirety much more easily than dense prose (Wigmore, 1913). CAAM also facilitates the comprehension of others' arguments, as it allows the reader to reconstruct the author's argument visually piece by piece, allowing ease of addition and rearrangement as new insights are gained (van Gelder, 1999, 2002). These aspects of CAAM led the participant researcher to develop the present action research study with an intervention employing CAAM to address the problem of practice she observed in her classroom regarding students' inability to analyze and compose evidence-based arguments.

CHAPTER 3

METHODOLOGY

The previous chapter presented a discussion of the theories and supporting literature relevant to the present action research study. This chapter will provide a description of the present study's context, the participant researcher's role in action research, the intervention used with the participants, and the methods of data collection and analysis utilized in the study. A practitioner's use of action research stems from a desire to use data-driven strategies to improve conditions within his or her particular context in a timely manner (Dana & Yendol-Hoppey, 2014; Mertler, 2014). To this end, the present participant researcher sought to improve student engagement and performance in argument analysis and construction because CT and generating evidence-based arguments have become increasingly important skills for students preparing for the 21st century workplace (Baker, 2010, p. 138-144; NGACBP and CCSSO, 2010; SCDE, 2015). Fletcher (2015) insists that the ability to understand and compose arguments is the most essential skill with which to equip today's students whether for college, the workplace, or everyday life.

Action Research Validity

Action research provides an empirical and systematic means to improve instructional practice within the confines of one's own classroom. Therefore, an action research study can be considered successful if it results in improved student achievement within the isolated research setting, but action research is also collaborative in that it is

conducted by educators to inform not only themselves and their classrooms, but other educators as well (Mertler, 2014). To that end, action research should be conducted in a manner which allows colleagues to benefit from it. While traditional research establishes its worth through validity and reliability that justify the generalizability of findings to a larger population, the rigor that allows others to benefit from the findings of action research takes the form of trustworthiness, which can be established by credibility, transferability, dependability, and confirmability (Stringer, 2014, p. 91).

Credibility of action research is beneficial to both the participants and other potential consumers of the study because it increases confidence in the findings and in the usefulness of the study both within, and, potentially, without the study's context. One way in which credibility can be established is through extended periods of data collection that "provide sufficient information" from which to draw conclusions (Stringer, 2014, p. 92). In the present study, the participant researcher collected pretest data, which provided a baseline from which to gauge change in the analysis and composition of evidence-based arguments; data from numerous formative assessments from which to gauge changes in students' ability to comprehend and analyze argumentative texts over the course of the intervention; and posttest data, which provided an indication of any change that had taken place during the study. In addition to academic data, affective data was collected using three attitude surveys administered before the pretest, mid-intervention, and prior to the posttest. The use of multiple forms of data allowed for polyangulation of the data, which increased the study's rigor by allowing "the [participant-] researcher to cross-check the accuracy of the data" (Mertler, 2014, p. 28). Closely related to credibility is confirmability, the degree to which consumers of the research can "confirm that the

procedures described actually took place" (Stringer, 2014, pp.93-94). Providing artifacts such as student work and detailed records of collected data help to establish confirmability (Stringer, 2014).

Whereas traditional research is concerned with generalization to a larger population, in regard to populations outside the context of the study, action research is concerned with transferability and dependability. Transferability is the ease with which another educator can determine whether his or her context is similar enough to the study's context to justify the application of the study to his or her classroom. Dependability is based upon the accuracy with which a participant researcher describes the procedures followed throughout a study. A thick, rich description of the study's participants, environment, and procedures allows colleagues to determine the transferability of a study to their specific contexts and enables colleagues to replicate a study within another similar context (Stringer, 2014, p.93).

Role of the Researcher

The role of the researcher in action research is that of participant as well as researcher. The participant researcher works alongside participants, students, parents, and other stakeholders, to discover some benefit to the particular population as opposed to the general population (Mertler, 2014). It is the participant researcher's duty to foster an atmosphere of trust in order to ensure that all stakeholders feel able to express themselves fully and to have their input valued. To create such an atmosphere, the participant researcher provided instruction in Burbules and Rice's (1991) tenets to foster an environment of civil "dialogue across differences" (p. 393). Due to the collaborative

nature of action research, the participant researcher is obligated to share findings with all stakeholders throughout, and at the conclusion of, the study (Mertler, 2014).

The participant researcher conducted this action research study to reflect upon her own practice and to solve a particular problem observed in her classroom. As the instructor for the English II classes participating in this study, the participant researcher was immersed in the setting, thereby facilitating prolonged engagement and persistent observation, which provided rigor in the action research. However, such a position also posed threats to research validity. Because the participant researcher held a position of authority within the research setting, there was the potential for acquiescence bias on the part of student participants. To minimize that threat to research validity, anonymous online surveys were conducted in lieu of interviews. Students and parents were assured that participation was voluntary and that non-participation would not negatively impact either the student's grade or the student's rapport with the participant researcher. To minimize confirmation bias, the participant researcher actively challenged her own preexisting assumptions about participants and results throughout the study. One of the most difficult challenges to overcome was the participant researcher's expectation of mastery that hindered her ability to recognize the growth the students made. Repeatedly reviewing the wording of the rubrics (see Appendices G & H) helped the participant researcher to judge what had been produced rather than what she wished had been produced.

Ethical Considerations

To conduct ethical research, the essential points of *The Belmont Report*, "respect for persons, beneficence, and justice," was reviewed (Office for Human Research

Protections, 1978), and the National Institute of Health's (NIH) (2015) course on protecting human research participants was completed. The participant researcher's intentions and procedures for data collection, the power relations among the various roles of participants, and potential negative impacts resulting from this action research study have been evaluated using Brown's (2010) self-interrogation questions (see Appendix A) (as cited by Dana & Yendol-Hoppey 2014).

The intention of this study is to forward student achievement and to help all students experience success in achieving significant academic goals. This research is in line with the CCSS (NGACBP & CCSSO, 2010), 21st century-skills acquisition, state standards, and district focus and will, therefore, not interfere with routine teaching duties or the educational experience expected in the classroom.

Data was collected from classroom assignments and surveys. All participants were made aware that their responses are voluntary, would not negatively affect their grade in the class or their relationship with the participant researcher, and would be presented anonymously. It was determined by the IRB that no letter of consent was necessary because the intervention was part of regular classroom assignments. However, participants were made aware that if they wished to cease participation in the study by excluding their data from the study, they would be able to do so without negative consequence.

The study's potential to anger or embarrass the participants was minimized by protocols to protect students' identities. This study was also concerned with un-silencing certain populations: females, students who hold non-mainstream beliefs, and students who feel uncomfortable taking a stand on an issue because they believe that to do so will

offend others with opposing beliefs. Therefore, before students began to conduct research and engage in informal conversational debate, Burbules and Rice's (1991) tenets were presented to foster an environment of civil pluralism.

Research Context

The present action research study was conducted in a large suburban high-school of approximately 2,339 students in grades nine through twelve as reported by the school's state-generated school report card. The school's male to female gender ratio is 1:1.2. Females not only slightly outnumber males in population, they perform marginally better than males in mathematics and significantly better than males in English language arts according to standardized test data. The racial makeup of the school is predominantly White, 67%. In math, there is a 48 point achievement gap between the highest performing racial group, Asians, and the lowest performing racial group, African-Americans; there is a 28 point achievement gap between Asians and African-Americans in English language arts. The amount of funding the school receives is comparable to the state average. Thirty percent of the student population is eligible for free or reduced lunch, which is significantly lower than the state average of 50%. Over 60% of faculty members have a graduate degree and more than five years of experience. The school is in the top 30% of schools in the state, based upon performance on national math and English language arts skills (Graphiq, 2016). The school operates on a four-by-four block schedule in which students complete four courses, which meet daily for 90 minutes each 18-week semester. The length of the class periods facilitated the completion of the present action research study as it allowed time for students to work on their argument assignments in class while still having time for other meaningful, concurrent instruction.

The target population for this action research study was a convenience sample of students assigned to my tenth grade English II class during the fall semester of the 2017-2018 school year. The population consisted of males and females aged 15-18. Demographic information was collected so that results could be compared by gender and race. A total of 75 students were invited to participate in this research project. Due to withdrawals from school and one expulsion, only 71 students completed the study. Class A contained 26 students, 13 females and 13 males. The racial composition of the class included seven African American students, one Asian American student, 16 White students, and two students declaring multiple races. Four students had *Individualized Education Plans* (IEPs) to provide accommodations for learning disabilities. One female student, classified as a ninth-grader, was almost 17 years old. Another female student, classified as a tenth-grader, was 18 years old. Class B contained 21students, 11 females and ten males. The racial composition of the class included eight African American students, 13 White students, two of whom identify as White Hispanic. Four students had IEPs to provide accommodations for learning disabilities. Class C contained 27 students, 14 females and 13 males. The racial composition of the class included eight African American students, one Asian foreign-exchange student from Japan, 17 White students, and two students declaring multiple races. Four students had IEPs to provide accommodations for learning disabilities.

Design of the Study

The present action research study consisted of a quantitative one-group pretest-posttest design, the purpose of which was to describe the impact of the use of guided practice in argument analysis and composition via CAAM on tenth grade students' ability

to analyze and compose evidence-based arguments. The study included attitude surveys (see Appendices B-D) to document changes in attitude toward the research process and argumentation throughout the study. Materials in this study were delivered via our school's learning management system, Schoology, which provides each student with an individual account. CAAM software and tutorials were accessed through individual student accounts at www.rationaleonline.com (CTS, 2013). All student work for this study was completed and submitted via students' individual laptops, provided through our district's 1:1 technology initiative. A recent infrastructure upgrade ensured ample bandwidth to handle the increase in Wi-Fi usage.

The Toulmin (2003) Argument Pattern (TAP) was chosen as the designated argument format because it focuses on supporting claims with evidence and refuting counterarguments. However, TAP introduces the concept of an argument's warrant. Identifying the warrant underlying a claim requires a sophisticated level of metacognition that many tenth grade students are unable to employ. The concept is addressed in the tutorial, but students were not expected to include that element in their argument maps. The Rogerian Argument Model (RAM) was rejected because it employs a persuasive strategy in which the author seeks common ground among conflicting perspectives (Kirschner & Mandell, 2011). Because English II students tend to gravitate toward expository writing, they might have misinterpreted the amount of objective discussion of alternative points of view as license to avoid formulating a clear position.

To begin the study, the participant researcher administered a pretest to determine a baseline of performance. The pretest was administered in three sections over five days. Students had at least 60 minutes of each 90-minute class to complete the pretest. The first

section of the pretest consisted of a pre-intervention Likert Scale survey (see Appendix B) on students' attitudes toward the processes of argumentation and research as a means of gathering support for an argument. The survey employed questions that required students to select emotions from a given list and rank those emotions from *most* to *least felt* and a section of questions for which students registered their level of agreement on a four-point Likert scale from *strongly disagree* to *strongly agree*. The online survey allowed students to respond anonymously, thereby encouraging honest answers.

The second section of the pretest consisted of a performance task designed to assess students' ability to analyze and compose an evidence-based argument. Given five teacher-selected articles on a debatable, socioscientific issue (one informational text and four argumentative texts), students read the informative article to gain background knowledge about the issue. To provide data on students' ability to comprehend and analyze arguments, students chose two of the argumentative texts of differing positions to analyze and presented a summary of each author's argument in graphic form using a teacher-provided graphic organizer familiar to the students. Our district utilizes Thinking Maps graphic organizers with students at every grade level from kindergarten to twelfth grade, so students had had experience using a tree map (see Appendix F), which is particularly suited to organizing essays (Hyerle & Yeager, 2007). Argument analysis maps were assessed by tallying the number of accurate elements identified within the selected arguments (see Appendix G). Students then formulated a stance on the on the issue and, using the five given sources, generated an evidence-based argument to advocate for their particular perspective. Arguments were presented graphically using the same organizer used to present the summaries of source arguments. Students' arguments

were assessed for the number of elements of an argument included logically and accurately (see Appendix H). To complete the pretest, students were given at least five hours of class time distributed over five days, which constituted week one of this six-week action research project.

Upon completion of the pretest, students began Rationale's CT tutorial, which provided instruction in the concepts of grouping, the hierarchy of ideas within an argument, and argument evaluation (CTS, 2013). During weeks two and three of this action research project, students completed daily online lessons. Each lesson was designed to be completed within 15 minutes, but since the lessons are appropriate even for educated adults, and the participants were high-school sophomores, the participant researcher allocated 30-45 minutes of class time for students to complete the lessons at their own pace. Students were also allowed to work on the lessons outside of class if they so desired. Ten days were allocated for completing the ten-lesson tutorial provided in the CAAM software. Students self-assessed their progress by comparing their work to the model answers provided by the tutorial.

Students were encouraged to proceed on to Rationale's argument mapping tutorial if they completed the CT tutorial early, thereby providing advanced students with enrichment in discerning co-premises and bases for assertions (CTS, 2013). The students then completed a mid-intervention Likert Scale survey (see Appendix C) on their attitudes toward the process of argument mapping and their perception of their ability to complete the assignments successfully.

In week four, students continued the intervention phase by applying the strategies learned in the tutorial to the analysis and mapping of two article-length arguments such as

they would use as sources in a research paper, as opposed to the shorter sentence- to paragraph-length arguments presented in the software's tutorial. Using Pearson & Gallagher's (1983) GRR instructional model, the participant researcher provided explicit, direct, whole-group instruction on argument analysis using arguments that she pre-selected. The participant researcher provided additional scaffolding in the form of decreased cognitive load during this assignment by eliminating the process of selecting a manageable, debatable topic. Yet, student agency was fostered through the students' ability to select source material to analyze from multiple articles presenting various perspectives on the issue. Students were also free to choose the stance they would defend in their composed argument.

The participant researcher modeled the process of argument analysis and the generation of a Rationale argument map (CTS, 2013). The whole-group lesson transitioned to small-group practice sessions as students read multiple source documents. The participant researcher guided students in self-assessing and peer-assessing the analysis maps using the same rubric (see Appendices G) used to assess the pretest. Teacher feedback was provided before the second analysis was conducted. The final portion of the task was the construction of an evidence-based argument presented in an argument map using CAAM software. Again, the participant researcher used modeling in a whole group setting to provide direct instruction in the composition process. Students were guided in self- and peer-assessing their arguments. Teacher feedback was provided before students began the week five composition map.

Week five involved individual practice in argument analysis and composition of evidence-based arguments using the same processes employed in week four of the

intervention. However, students were encouraged to discuss articles and issues with peers to deepen their understanding before individually creating analysis and composition maps. Students produced two analysis maps and one composition map. Before the posttest was conducted, peer and teacher feedback for these assignments was provided using the same rubrics (see Appendices G & H) used to evaluate the pretest.

During week six, the participant researcher administered a posttest of the same nature as the pretest in order to determine the impact of the intervention on students' ability to analyze and compose evidence-based arguments over the course of the study. Students worked individually in the production of analysis and composition maps, though they could consult with peers about source material to deepen their understanding prior to map generation. Peer feedback was not provided on posttest maps prior to submission. Students' arguments were assessed using the same rubrics (see Appendices G & H) that were used to assess the pretest.

Data Collection Instruments and Procedures

During the course of the present quantitative action research study the participant researcher collected multiple sources of data to establish the trustworthiness of the findings. Data sources included:

- Attitude surveys: pre-, mid-, and post-intervention
- Argument analysis maps: pretest, guided practice, and posttest
- Argument composition maps: pretest, guided practice, and posttest.

Attitude surveys. Three online attitude surveys (see Appendices B, C, & D) were administered via Google forms pre-, mid-, and post-intervention. Each survey collected anonymously reported data on student attitudes towards research and argumentation

assignments. The mid-intervention survey contained only questions about argumentation because there were no research activities involved in the CAAM tutorial. The surveys required students to select three words that best described their feelings about research and argumentation assignments. An alphabetical checklist of 16 adjectives, divided equally between positive and negative emotions, accompanied the question. Students then ranked their chosen words according to the relative strength of the emotion (*felt most*, *less*, and *least strongly*). A four-point Likert scale measured students' agreement with statements on research and argumentation from *strongly agree* to *strongly disagree*. While no question on the survey was required, this section was a type of forced response in that the nature of the scale forced students to declare agreement or disagreement, whether mild or strong. The participant researcher believed that forcing students to declare agreement or disagreement would yield a better representation of students' feelings than providing a neutral option that potentially could have subsumed the opinions of those students who would have chosen a neutral option to avoid reflecting upon or expressing their feelings. Question topics on research included the creation of a thesis, reading comprehension, note taking, source integration, source documentation, and the presentation of students' research in various formats. Question topics on argumentation included the place of opinion in argument, comfort with the possibility of their opinions' offending others or of contradicting others' opinions, the information search process, and students' ability to generate an argument successfully. The 16 question mid-intervention survey contained 12 questions about students' attitudes toward argumentation from the pre-intervention survey. For questions 13 through 16, students rated on a four-point Likert scale their disagreement or agreement with each statement

about CAAM. The post-intervention survey combined the questions from the previous two surveys. The data from these surveys provided insight into the impact of the intervention on students' attitudes toward generating researched arguments using CAAM.

Argument maps and assessment rubrics. The rubrics (see Appendices G & H) used to determine pretest and posttest scores provided an assessment of students' ability to analyze and compose evidence-based arguments. These instruments were used to collect data from assignments including a baseline pretest, formative assessments, and a posttest. Argument analysis maps were evaluated for accuracy (e.g. accurate identification of the contention, accurate identification of the main reasons, accurate association of a reason with supporting evidence, and accurate identification of objections and rebuttals) as an indication of a student's comprehension of the source documents that they would use to construct their own arguments, which could have affected a students' ability to compose an argument on that issue. Argument composition maps were evaluated for the presence of the essential elements of an argument (e.g. a clear contention, multiple reasons, relevant supporting evidence, and acknowledgement of objections with corresponding rebuttals). Because the participants were novices at argumentation, the quality of an argument was not assessed beyond the presence of the elements of an argument, the accuracy of information, and the reasonable use of source material.

Data Analysis

Participants generated two analysis maps and one composition map at each of four benchmarks, the pretest, week four, week five, and the posttest. Each set of maps received an analysis score, determined by averaging the two analysis map scores, and a

composition score. The analysis average and the composition score were averaged to generate a composite score that represented analysis and composition skills equally. For each benchmark, the sample mean score and standard deviation were calculated for each component and the composite score.

Sample mean benchmark scores were compared to determine percent change from the pretest and between benchmarks. A right-tailed paired samples *t*-test was performed to determine whether the percent change noted was statistically significant. Cohen's *d* was calculated to determine whether the effect size of the change was small (.02), medium (.5), or large (.8). Scores were also disaggregated and analyzed by race and gender to determine the impact of the intervention upon minority participants.

Attitude survey data was collected at three points throughout the study, pre-intervention, mid-intervention, and post-intervention. Participants chose from given list adjectives describing their attitudes toward research and argumentation. Those choices were tabulated to determine the most common descriptors and the top three choices were reported by the percentage of participants who chose that descriptor. Comparison graphs (Tables 4.3 & 4.4) display the change in each of the 16 given attitude descriptors across all three surveys. Using a Likert-scale survey, participants reported their level of agreement with statements about research and argumentation. The scale included four levels: *strongly disagree*, *disagree*, *agree*, and *strongly agree*. Responses were tabulated to determine the percentage of participants showing agreement or disagreement with each statement. Percent change in participants' agreement or disagreement was compared from survey to survey. Because surveys were completed anonymously, disaggregation of that data by race and gender was not possible.

It would be inappropriate to use inferential statistics to generalize the findings of this study to the entire population of tenth grade English II students for several reasons. The participants of this study did not comprise a random sample, no control group was used, and the measurement instruments were not standardized. However, as the data was quantitative, it made sense to use statistical analysis as a method of comparison within this study. It is important to remember that the presence of change coinciding with the introduction of CAAM cannot be construed as definitive evidence that CAAM caused the change.

Limitations of the Study

The purpose of the present action research study was to describe the impact of the use of guided practice in argument analysis and composition via CAAM on high school students' ability to analyze and compose evidence-based arguments. The composition of said arguments did not include the generation of a formal essay, but rather the generation of reasons, evidence, counterarguments, and rebuttals to support a contention, presented graphically in such a way as to indicate the progression of logic throughout the argument. This study did not address the relative strength or weakness of the argument composed. The only evaluation of quality was whether the evidence selected was relevant to the reason it was intended to support and whether the student engaged in appropriate use of source material (i.e. not using significantly more quoted source material than was warranted for the purpose). Nor did the present study address the skills of topic selection or source selection and evaluation. Topics were selected by the participant researcher in order to eliminate potential problems with topic selection as a confounding variable and

to allow the participant researcher to have a rich understanding of the various aspects of each topic, thus enabling her to better assess students' arguments.

Summary

Inspired by social reconstructionism's view of the purpose of education and cognitivist and constructivist learning theories, the purpose of this quantitative action research study was to describe the impact of the use of guided practice in argument analysis and composition via CAAM on tenth grade students' ability to analyze and compose evidence-based arguments. Students completed a pretest on the analysis and composition of evidence-based arguments in which analyzed arguments were reconstructed and original arguments composed and presented in a graphic organizer familiar to students. Upon gathering baseline performance data, the participant researcher provided students instruction and extensive practice in argument analysis and composition via a CAAM tutorial and teacher-created assignments designed to simulate the task of composing an argumentative research paper. The posttest consisted of the analysis and composition of evidence-based arguments in the form of Rationale argument maps (CTS, 2013). A comparison of quantitative benchmark data, including sample means, their accompanying standard deviations, and percent change, was used to determine what change, if any, was experienced over the course of the intervention. A right-tailed paired samples *t*-tests determined the statistical significance of the change, and Cohen's *d* was used to calculate the effect size of the intervention. Data was analyzed for differences among races and genders as well to determine the effect of this intervention on minority voices. Anonymous surveys provided insight into the impact of the use of CAAM on student attitudes toward research, argumentation, and Rationale.

Table 3.1 Intervention Schedule

Phase	Duration	Participant researcher Procedures	Participant Procedures
Pretest	5 days/ Wk 1	1. Administered attitude survey via Google Forms 2. Assigned and provided source material for the creation of two analysis maps and one composition map 3. Evaluated students' argument maps and recorded data; no feedback was provided	1. Completed attitude survey on research and argumentation 2. Created two analysis maps and one composition map using provided source material
Tutorial	10 days/ Wks 2 & 3	4. Assigned ten tutorial lessons in Rationale; feedback was provided via worked solutions within the tutorial	3. Completed ten self-paced, online tutorial lessons, self-assessing via worked solutions
Mid-Point Survey	<1 day	5. Administered attitude survey via Google Forms	4. Completed attitude survey on argumentation
Application Practice	10 days/ Wks 4 & 5	6. Assigned and provided source material for the creation of two analysis maps & one composition map per topic per week 7. Evaluated students' argument maps, recorded data, and provided feedback via conferencing	5. Created two analysis maps and one composition map per topic per week using provided source material 6. Participated in student-teacher conferences to receive feedback
Posttest	5 days/ Wk 6	8. Assigned and provided source material for the creation of two analysis maps and one composition map 9. Administered attitude survey via Google Forms 10. Evaluated students' argument maps, recorded data, and provided feedback via completed assessment rubric	7. Created two analysis maps and one composition map using provided source material 8. Completed attitude survey on research and argumentation 9. Received feedback via completed assessment rubric

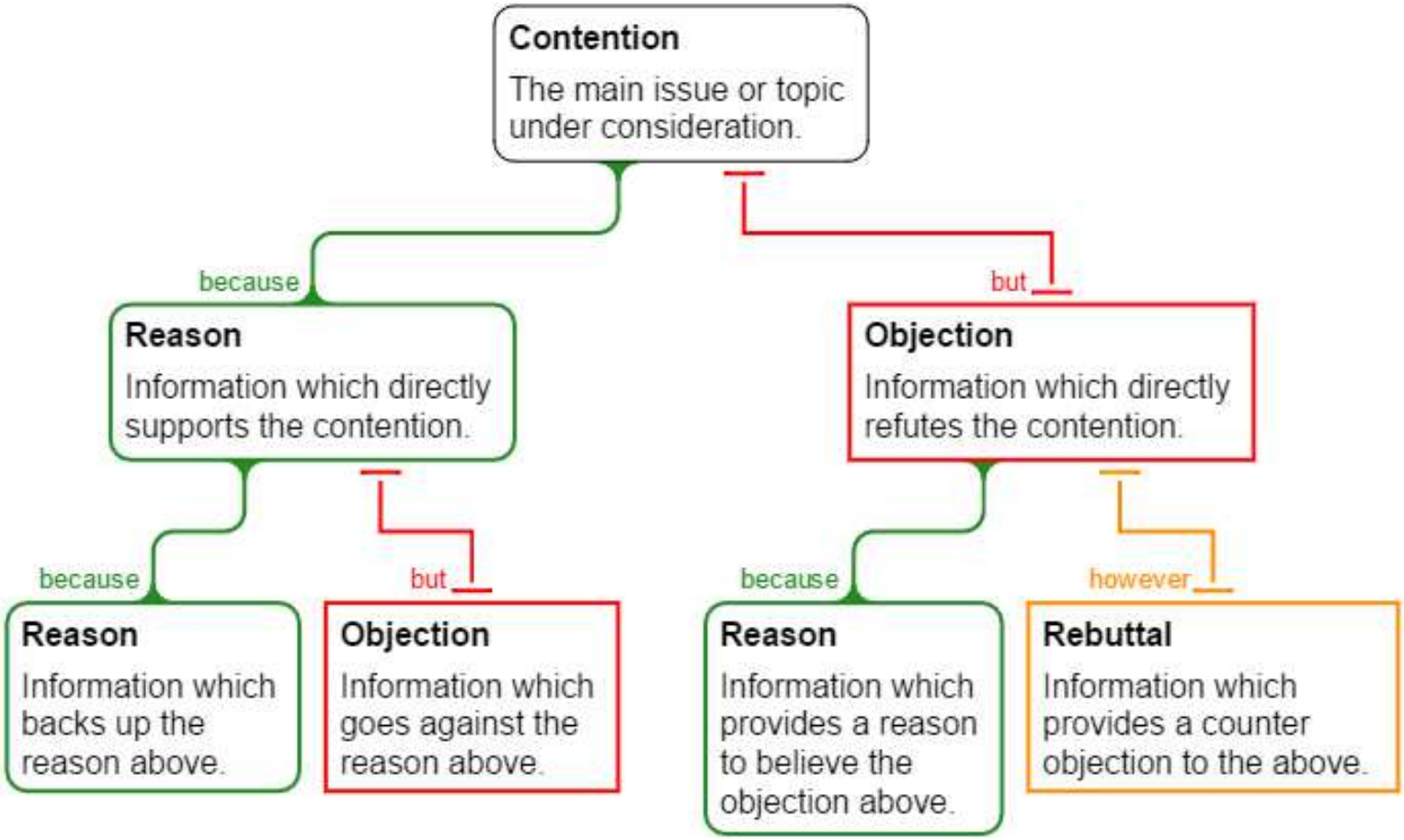


Figure 3.1 Example of a Rationale-style Argument Map

Note. From Rationale [Computer software], by Critical Thinking Skills BV (CTS) (https://www.rationaleonline.com/).

CHAPTER 4

FINDINGS FROM THE DATA ANALYSIS

The purpose of this quantitative action research study was to document the impact of the use of CAAM upon high school students' ability to analyze and compose evidence-based arguments. The participant researcher's 71 high school sophomores served as a convenience sample. At each of four benchmarks during the six-week study, students generated two argument analysis maps from teacher-provided articles on the benefits and drawbacks of a given topic and one argument composition map representing the students' individual position on the given topic. Upon having read an informational overview of the topic and multiple arguments, students selected two arguments of differing positions to analyze and reconstruct in argument map format. Such a format visually presented an argument in a pyramid-like structure in which the main contention formed the apex and was supported by assertions and evidence in subsequent layers beneath (see Figure 3.1). Maps were evaluated for the accuracy with which students identified the author's main contention, major points of evidence, counterarguments, and rebuttals. Having displayed an understanding of the source material via their analysis maps, students then formulated a position on the topic and presented their own arguments in map form.

Between the pretest and week four, students completed a self-paced computerized tutorial on CT that emphasized argumentation skills, such as grouping ideas, recognizing the parts of an argument, locating arguments in a text, evaluating arguments for errors in logic and credibility, and creating argument maps. In weeks four and five of the study,

students applied the skills learned in the tutorial to full-length argumentative articles provided by the participant researcher. Benchmarks for weeks four, five, and the posttest consisted of the same task as the pretest, two analysis maps reconstructing the authors' arguments and one argument composition map representing the students' position on the given topic. Composite scores were analyzed to determine an overall effect, while each component score, analysis and composition, provided an indication of reading comprehension ability and argument construction ability, respectively. The findings have been presented first in participants' work samples, then in quantitative score data, and finally in attitude survey data.

Participants' Work Samples

Argument mapping provided opportunities to correct misunderstandings during the exploration phase of the ISP (Kuhlthau, 1994) as students displayed their understanding of authors' arguments by reconstructing them in map form. The map in Figure 4.1 revealed that the participant may have been unsure of the difference between traditional genetic modification at the plant level and modern genetic modification at the DNA level because box 14 mentions a modern GE crop, but box 16 mentions early man's development of wheat as a cultivated crop. Both boxes 14 and 16 are used to support box eight, which appears to refer to modern genetic techniques since box nine refers to modification techniques predating the discovery of genes. If the participant fully understood the concept or the article, boxes 16, 17, and 19 should have supported the box nine, which refers to primitive agricultural technology. Box 11 is not a counterargument against the main contention because each idea refers to different methods of genetic modification; box 11 and its accompanying rebuttal in box 18 actually support box 17's

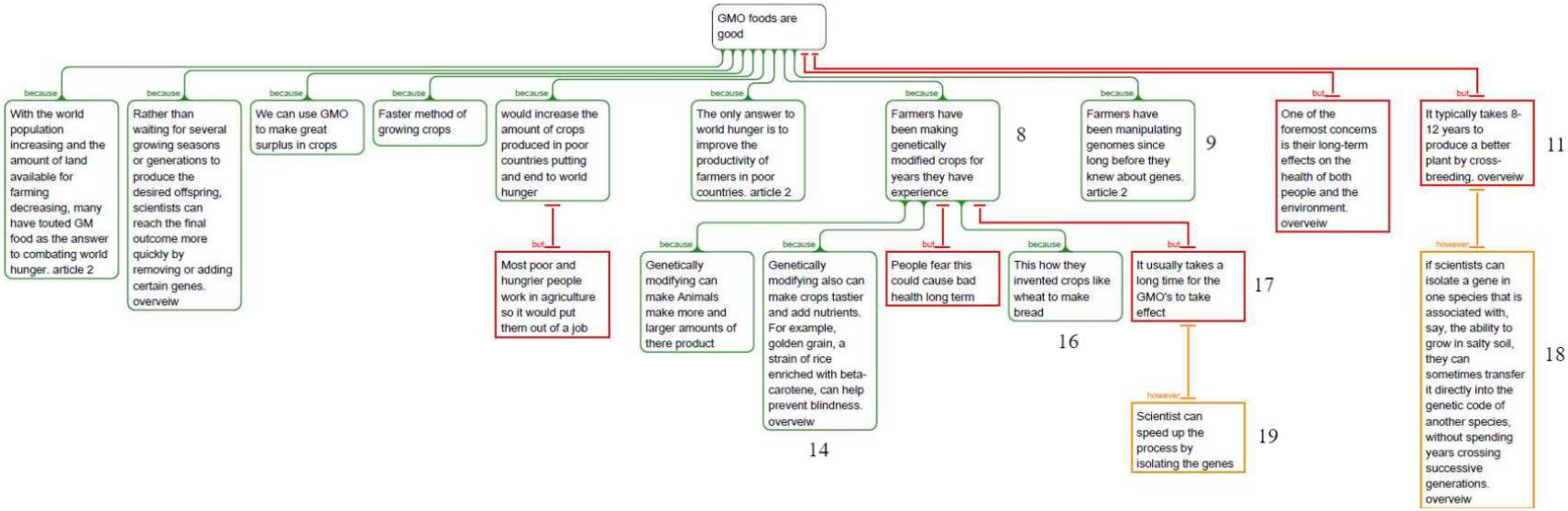


Figure 4.1 Participant's Work Sample in Rationale's Basic Argument Map Format

Note (CTS, 2013)

suggestion that primitive agricultural techniques require a great deal of time. Correcting this kind of misunderstanding before the student generates a prose draft allows the student to deepen his or her understanding, which will produce a better paper and contribute to feelings of self-efficacy, which will positively impact future attempts at CT (Bandura 1977, 1997; Ericsson & Charness, 1994).

Figure 4.2 contains a participant's advanced argument map, which allows for the use of co-premises, ideas that work together to make a point. The combination of the facts, that "Bt toxin is released via plants' root systems, remains active for 234 days," and "ongoing exposure fosters pesticide resistance," creates a single idea that supports the main contention (Figure 4.2). These ideas function as co-premises because the ideas do not provide evidence that the other ideas are true or valid; instead, the proximity of the ideas serves to illustrate the significance of the association. Separating each idea allows for more precise support or contradiction. For example, the supporting evidence on the third level of the map, "Resistance to Bt has already been detected in certain insects," does not prove that "the toxin can remain active for at least 234 days," nor does it prove that "Bt toxin is released into the soil through the roots of Bt corn plants," but it does support the idea of "ongoing exposure…promot[ing] resistance," which can be developed into a detailed sub-argument containing its own counterarguments and rebuttals (Figure 4.2). A discussion of such a development can be found in the Implications for Praxis section of Chapter 5 of this dissertation.

Composite Scores

The composite benchmark scores (see Table 4.1) were calculated by averaging the analysis map score average with the composition score such that the score represents both skills equally. Change was measured not only from the pretest, but also from one

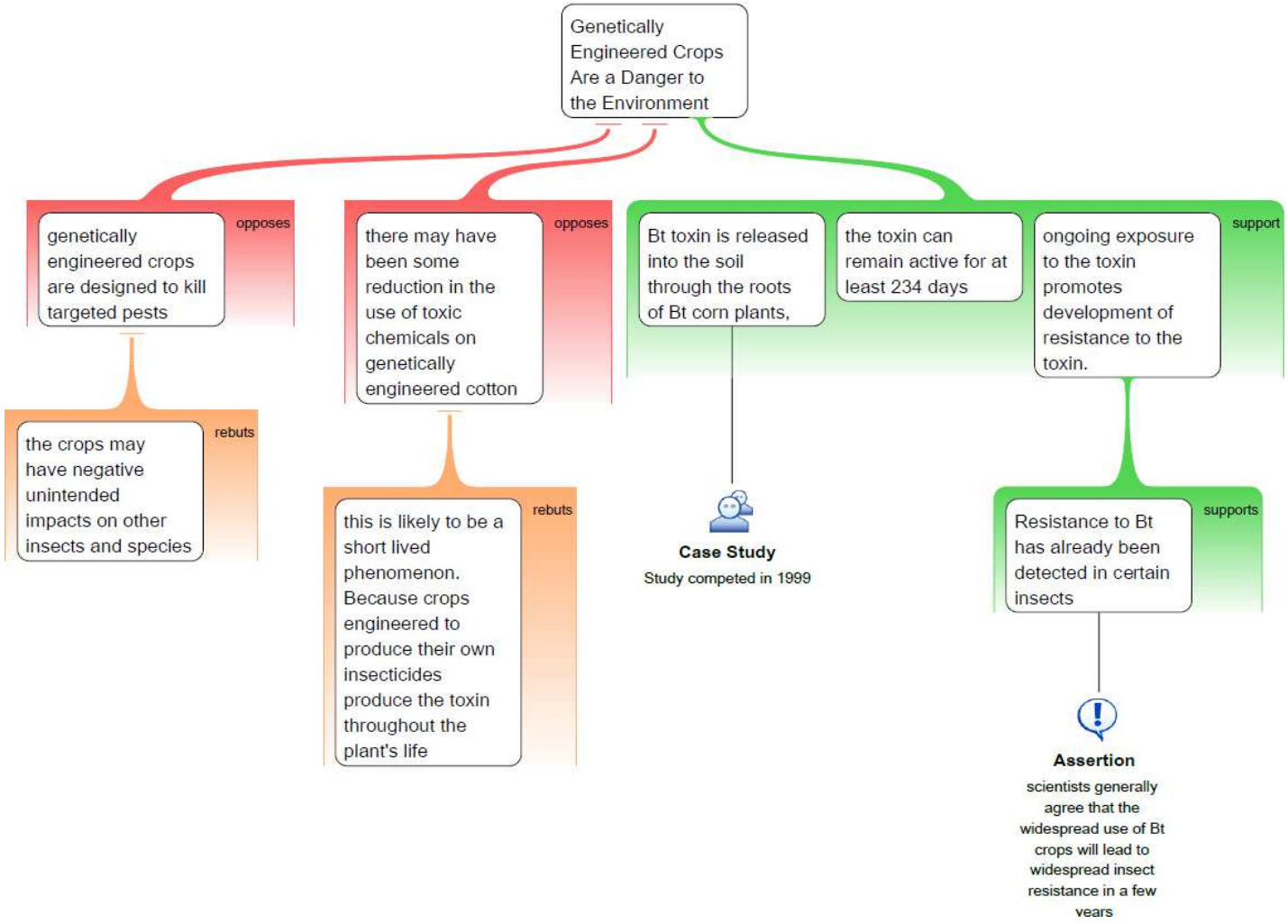


Figure 4.2 Participant's Work Sample in Rationale's Advanced Argument Map Format

Note (CTS, 2013)

benchmark to the next. The sample mean of the composite pretest scores was 1.1681(*SD* 0.3583) out of a possible three points. After completion of the CAAM tutorial, the sample mean score on the week four benchmark, 1.5585 (*SD* 0.4119), rose by a difference of 0.3904 (*SD* 0.4617) points for an increase of 57%. A right-tailed paired samples *t*-test was used to evaluate the statistical significance of the change in scores from the pretest to each of the benchmarks. The difference in sample means between the pretest and the week four benchmark score returned a *t* value of 7.1255 with a critical *t* of 1.70 for *N*=70, indicating statistical significance to .05 at a 95% confidence level. A calculation for Cohen's *d* revealed a large effect size of .845

Table 4.1 Improvement from Pretest to Posttest Composite Scores

Percent increase	Number of participants achieving this level of improvement	Percentage of participants achieving this level of improvement
<10%	17	24%
10-49%	29	41%
>=50%	8	11%
>=100%	17	24%
N=71	71	100%

Though the sample mean continued to rise from the week four to the week five benchmark by 0.0405 (*SD* 0.3987), the difference was not found to be statistically significant. The mean score rose again during the posttest, 1.6554 (*SD* 0.5056), to exceed the mean pretest score by a difference of 0.4872 (*SD* 0.5327), a 26% increase, with a *t* value of 7.7077. Compared to a critical *t* of 1.67, the data indicates statistical significance

to the .05 level for a 95% confidence level. A calculation for Cohen's *d* revealed a large effect size of 0.9147.

Analysis Component Scores

Analysis maps represented a reconstruction of the arguments made in source documents; therefore, these maps can be seen as representing participants' reading comprehension ability. Maps were evaluated for the accurate identification of the author's contention, major reasons, supporting evidence, counterarguments, and rebuttals. Pretest analysis map scores produced a sample mean of 1.2236 (*SD* 0.3930) out of a possible three points. The sample mean score on the week four benchmark increased by a difference of 0.4287 (*SD* 0.4759) points, a 78% increase, returning a *t* value of 7.5903.

Comparison with a critical *t* of 1.67 indicates statistical significance to .05 with a 95% confidence level. The calculation of Cohen's *d* revealed a large effect size of 0.9008. The 5% decrease, -0.0229 (*SD* 0.4033), in the sample mean score for analysis maps from the week four to the week five benchmark was not found statistically significant. However, the sample mean of the analysis map scores increased from the pretest (1.2236 (*SD* 0.3930)) to the posttest (1.7192 (*SD* 0.5136)) by a difference of 0.4956 (*SD* 0.4354). Comparison of the resulting *t* value of 9.5919 with a critical *t* of 1.67 indicates statistical significance to .05 with a 95% confidence level. The calculation of Cohen's *d* revealed a large effect size of 1.1383.

Composition Component Scores

The argument composition map was evaluated for the presence of a contention, logical reasons, accurate supporting evidence, a counterargument, and a rebuttal. Because the students were novices in argument analysis and composition, the strength of the

argument was not a component of the score. Table 4.2 displays a comparison of the composite and component scores.

Table 4.2 A Comparison of Composite and Component Gains

% increase from pretest to posttest	Composite Score	Argument Analysis	Argument Composition
<10%	24%	31%	41%
10-49%	41%	17%	14%
>=50%	11%	32%	11%
>=100%	24%	20%	34%
total	100%	100%	100%

Note. N=71

The sample mean score for the composition portion of the pretest was 1.1127 (*SD* 0.4924) out of a possible three points. The sample mean composition score increased from the pretest to the week four benchmark by a difference of 0.3521 (*SD* 0.6350), a 31.6% increase. A comparison of the resulting *t*-test value (4.6721) to a critical *t* of 1.67 reveals statistical significance to the .05 level with a 95% confidence level. A calculation of Cohen's *d* revealed a moderate effect size of 0.5545. The seven percent increase in the sample mean composition score from the week four to the week five benchmark was not found statistically significant. However, the week five sample mean composition score increased by 41% from the pretest score. That increase of .456 (*SD* 0.7574.) was found to be statistically significant at the 0.05 level with a *t* value of 5.0727 and a moderate effect size of $d = 0.6020$. The 1.5% increase in mean composition score from week five to the posttest was not found statistically significant, but the 43% increase in mean composition

scores from the pretest (1.1127 (*SD* 0.4924)) to the posttest (1.5915 (*SD* 0.6882)) was determined to be statistically significant to the 0.05 level with a *t* value of 4.8367 and a moderate effect size of $d = 0.5740$.

Disaggregation of Scores by Gender and Race

The data was analyzed by gender and race to determine whether there were different effects on the following groups: female (n=32), male (n=39), African-American (n=21), and White (n=41). No participants identified as transgender or non-binary. The number of people of races other than African American or White was too small to be analyzed statistically either as individual races or as a combined group of people of color: East Asian (n=1), Hispanic (n=4), South Asian (n=1), and people of multiple races (n=3). Because of the tendency for Cohen's *d* to return inflated the effect sizes for small populations (N<50), the formula corrected for small sample sizes was used to generate effect sizes for the disaggregated data.

Males displayed four percent higher composite mean scores, four percent higher average percentage increase from pretest to posttest, and 13% larger effect sizes than their female counterparts. The mean percentage increase for males, including the analysis, composition, and composite scores was 44%, while mean percentage increase for females was 40%. White participants displayed 15% percent higher composite mean scores, 33% percent higher average percentage increase from pretest to posttest, and 59% percent larger effect sizes than their African-American counterparts. The mean percentage increase for White participants, including the analysis, composition, and composite scores was 46%, while mean percentage increase for African-American participants was 31%.

Attitude Survey Data

Three surveys were administered throughout the study, pre-, mid-, and post-intervention to collect data on participants' attitudes towards research and argumentation. The mid-intervention survey contained only questions regarding argumentation because the CAAM tutorial portion of the intervention immediately preceding it did not address research topics. Sixty-six participants responded to the pre-intervention survey yielding a 93% completion rate. Fifty-eight participants responded to the mid-intervention survey, yielding a completion rate of 82%. Forty-three participants responded to the post-intervention survey, yielding a completion rate of 61%. The data was reported anonymously using a Google Form.

Emotion Descriptors and Rankings

The first section of the pre- and post-intervention surveys gathered data on student attitudes toward research, which respondents were instructed to interpret as gleaning information from source documents to use in composing a paper, as opposed to other aspects of research that were not a part of this intervention, such as the generation of research topics or source selection. Respondents were provided a list of 16 descriptors, eight positive and eight negative, presented alphabetically, from which they were asked to select three descriptors that best described their feelings toward research. Table 4.3 displays a comparison of the percentage of respondents who chose a particular emotion on the pre-intervention survey to the percentage who chose that same word on the post-intervention survey. Over the course of the intervention, the selection of negative descriptors decreased by six percent, with a corresponding increase of six percent in positive descriptors. Respondents were instructed to rank the three descriptors they had

chosen as being *most*, *less*, or *least felt*. At the pre-intervention survey, the two descriptors felt most strongly were *bored* and *overwhelmed*, each having been selected by 20% of respondents. At the post-intervention survey, the two descriptors felt most strongly were *calm*, selected by 19% of respondents, and *frustrated*, selected by 16% of respondents. The choice of *tired* to describe attitudes toward research increased by 41% from the pre- to the post-intervention survey. The choice of *relaxed* also increased by 54%. The choice of *optimistic* and *clear-headedness* regarding research increased by 90% and 120%, respectively.

Table 4.3 Attitudes Towards Research

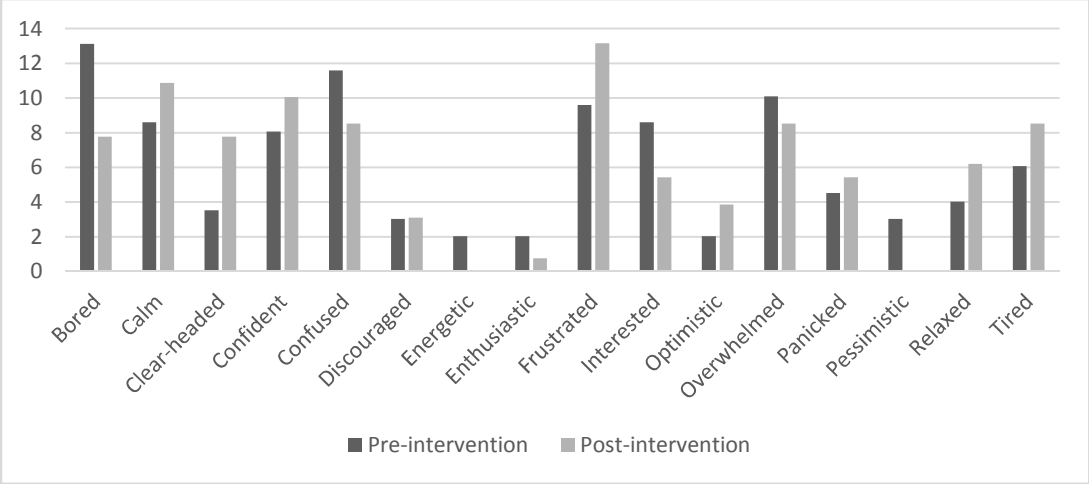
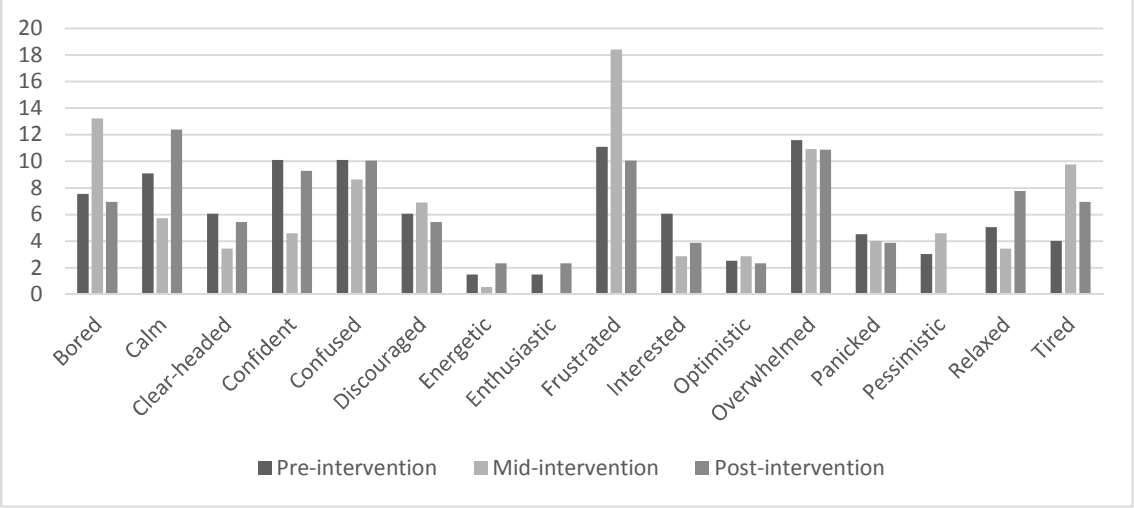


Table 4.4 displays the difference in the percentage of respondents who chose a particular emotion to describe feelings towards argumentation on the pre-, mid-, and post-intervention surveys. Positive emotional descriptors regarding argumentation did not increase from the pre-intervention survey to the mid-intervention survey. The midpoint of the intervention saw spikes in respondents feeling *bored* and *frustrated*, but subsided at the post-intervention survey to a 13% and 9% decrease from pre-intervention levels, respectively. Respondents choosing *calm* to describe their feelings towards

argumentation increased by 33% from the pre-intervention survey, while respondents choosing *relaxed* increased 60%. However, the percentage of participants reporting feeling *overwhelmed* remained relatively steady throughout the intervention with only an eight percent decrease from the pre- to the post-intervention survey.

Table 4.4 Attitudes Towards Argumentation



The emotions ranked as being felt most strongly at the pre-intervention survey were *calm* with 15% of respondents having chosen it and a three-way tie among *confident*, *confused*, and *frustrated*, each one having been chosen by 12% of respondents. On the mid-intervention survey, there was a three-way tie for the emotion felt most strongly, *bored*, *confused*, and *frustrated* were each chosen by 16% of respondents. On the post-intervention survey, *calm* was chosen by 19% of participants for an increase of 27% from the pre-intervention survey. Though *frustrated* and *tired are* negative descriptors, they imply engagement with the task and expended effort as opposed to *bored* or *overwhelmed*, both of which imply passivity. Since one of the goals of the present study's intervention was to increase engagement, these negative descriptors can be interpreted as positive indicators.

The participant researcher observed task-fatigue in the participants similar to that reported by Carwie (2009) whose nursing students were concerned about having to reallocate content study time to mastering CAAM. Butchart et al.'s (2009) participants did not report negative feelings toward argument mapping; however, the subject matter of the course was CT, so there was no conflict between time spent learning argument mapping vs. time spent learning subject matter. Similarly, the participants in the present study felt no pressure to retain content knowledge of the issues they argued because acquiring the skill of argumentation was the intended subject matter, yet frustration was still an issue. Argument maps are a coded form of communication, using visual cues to express ideas, such as the color red to indicate contradiction or a hierarchical level to indicate the specificity of an idea. It is like learning a new language, so it is understandable that novices would experience frustration and fatigue (Buckingham Shum, 2003; Twardy, 2004; van Bruggen, 2003; van Gelder, 2005). While Butchart et al.'s (2009) undergraduate participants worked with argument maps 30-45 minutes per week for 18 weeks, the high-school sophomores in the present study spent 30-45 minutes per day for 6 weeks. Extending the intervention over a longer period, and reducing the amount of time spent daily may mitigate that fatigue without sacrificing the amount of practice provided.

Likert-Scale Responses

While respondents' agreement or strong agreement with liking to engage in formal argumentation increased throughout the study by 15% to a total of 28% of respondents, participants also expressed increasing discomfort throughout the study with the possibility of contradicting others (49% of respondents) or giving offense (42% of

respondents) when expressing their opinion on an issue. Perhaps the print format of their formal arguments offered a less emotionally-charged platform for expression than the face-to-face dialogues they engaged in, thereby contributing to the increase of appreciation for formal argumentation. Though a minority of respondents (28-40%) expressed agreement or strong agreement with enjoying research or argumentation, 43% more respondents reported liking research assignments than reported liking argumentation assignments. It may be that the more cognitively demanding process of argumentation contributed to participants' preference for research over argumentation. Over the course of the study, agreement or strong agreement with liking the use of CAAM decreased by 14% from 57% of respondents to 49%. While the participant researcher had hoped that a computerized argumentation platform would increase enjoyment in the task of argumentation, Ericsson's et al. (1993) work on the achievement of excellence through deliberate practice does not list enjoyment as a requisite for improved performance, and the current study's participants did display improvement in analyzing and composing evidence-based arguments, regardless of their reported waning enjoyment.

Participants' agreement or strong agreement that opinion alone is insufficient to support an argument increased by 5.4% at the midpoint survey, climbing to a 15% increase from the pre-to the post-intervention survey, for a total of 49% of respondents. However, that understanding was not reflected in the 44% increase in participants' agreement or strong agreement that formal and informal argumentation are the same. These terms were used to differentiate between the casual, conversational arguments that rarely contain the more sophisticated elements of argumentation, and formal arguments

that seek to influence opponents through concessions to the opposition and logical, evidence-based rebuttals to counterarguments (Kuhn, 1991; Losh et al., 2017). Participants' disagreement or strong disagreement with feeling confusion about what to look for when analyzing an argument, and their improvement in including elements of formal arguments, such as counterarguments and rebuttals, in their argument maps belies their assertion that formal and informal argumentation are the same. It is possible that throughout the study, participants began to understand that even conversational arguments can benefit from the elements of formal argumentation, and that understanding led students to equate the two. This seeming disparity reveals a weakness in the question rather than a lack of understanding in the participants.

Seventy percent of respondents agreed or strongly agreed that it is important to compose a thesis before taking notes from source material, an increase of 31% from the pre- to the post-intervention survey. Student confusion about what information to glean from sources during notetaking decreased by 13% among respondents over the course of the study, with 61% of respondents reporting confidence in that skill. Respondents' self-perceptions of their comprehension of source material increased by 27% from the pre- to the post-intervention survey, with 56% reporting agreement or strong agreement that they could easily understand the documents most of the time. It may be that students' adherence to effective information search practices, such as composing a thesis before beginning to take notes (Kuhlthau, 1994), contributed to their perception of increased comprehension.

Over the course of the study, students' confidence regarding the integration of sources and recognizing the ways authors address opposing arguments increased by

seven percent, with 61% of respondents reporting agreeing or strongly agreeing with having confidence in their abilities. Sixty-five percent of respondents agree that citing sources is a necessary task, an increase of 11% from the pre-intervention survey, and 60% of respondents affirmed confidence in that skill. Though confidence in the ability to successfully generate documented research increased by 29% among respondents, with 61% reporting agreement or strong agreement in their confidence, that confidence did not extend to the presentation of researched arguments, regardless of presentation format, in the post-intervention survey. Of the three presentation methods mentioned in the survey, essay, oral presentation, and multi-media format, students reported the least confidence in the multi-media format, which respondents were instructed to interpret as argument map format, as opposed to the more traditional essay. Sixty-one percent of respondents reported confidence in their ability to successfully present research in research paper format, an increase of 24% from the pre-intervention survey. Since the intervention did not include essay composition, this confidence might seem to be an uninformed opinion. However, it may be that students felt more prepared to compose such an essay as a result of the increased cognitive processing of the data prior to composition; whereas, the participant researcher's former students often skipped directly to composition as they read source documents. Having greater command of the subject matter would provide students with something to say, thereby facilitating essay composition.

Twenty eight percent more respondents (47% of respondents) reported confidence in presenting researched arguments orally than reported confidence in multimedia format. Fourteen percent fewer respondents (52% of respondents) agreed or agreed strongly with having confidence in their ability to present an argument in multi-media format than in

traditional essay format. It is possible that familiarity alone prompted this choice, or it may be that weaknesses in an argument are more easily recognized in map form than in prose, thereby requiring more work and better preparation before composing. This aversion to non-traditional presentation formats was echoed in the 14% decrease from 57% to 49% of respondents agreeing or strongly agreeing that they liked the use of CAAM software.

Analysis

In order to determine whether the observed change in scores from pretest to posttest was of practical significance, participants' gains were compared to gains made in similar studies. The current study used Cohen's *d* to report a standardized effect size of 0.9147 for the increase in the mean composite score from the pretest to the posttest. This increase is comparable to the $d = .8$ gain observed by van Gelder et al. (2004) and exceeds the $d = .45$ gain observed by Butchart et al. (2009) and the $d = .4$ gain observed by Dwyer et al. (2012). It is important to note that, while these studies provide a point of comparison, it would be inappropriate to equate the gains observed in the current study with the gains observed in the other studies due to the difference in the measurement instrument employed in each study. All three aforementioned studies employed a standardized CT measurement instrument to determine the intervention's effect. This participant researcher had no access to such instruments during the current study. The gains reported in this study reflect an improvement in performance on a task that was repeated four times throughout the study, the reconstruction of expert arguments and the construction of an original argument all in argument map format. Such a method could reflect gains caused merely by repeating the same task, albeit with different texts.

However, for the participant researcher's needs, namely the improved performance of her particular students in comprehending and composing arguments, such a posttest served its purpose.

CHAPTER 5

DISCUSSION

The purpose of this quantitative action research study was to investigate the following research questions:

1. *What is the impact of the use of CAAM on high school students' ability to analyze evidence-based arguments?*
2. *What is the impact of the use of CAAM on high school students' ability to generate evidence-based arguments?*
3. *What is the impact of the use of CAAM on high school students' attitudes toward research and argumentation?*

The study was conducted in the participant researcher's tenth grade English II classroom using a convenience sample comprised of her three semester-long classes. The six week intervention consisted of a pretest (one week), a tutorial in CT via the use of argument maps (two weeks), two practice sessions (one week each) using full-length arguments, and a posttest (one week). The use of CAAM as a means of fostering the CT skills necessary for the comprehension and composition of arguments (analysis, synthesis, and organization) proved beneficial, with the results of the study showing both significance (t=7.7077, crit. t=1.67, $\propto = 05$, 95% confidence level) and an appreciable effect size (d = .9147).

Lessons Learned from the Study

The intervention employed in this action research study was intended to improve students' ability to comprehend and compose argumentative texts through the use of a very specific type of graphic organizer, argument maps, which would function as a form of external working memory to hold and organize students' thoughts and understandings as they strove to comprehend or compose a text more deeply (Bell, 1997; Clark, R. et al., 2006; Hyerle & Yeager, 2007; Paas et al., 2003; Suthers, 2014; Sweller, 1988; Sweller et al., 1998, 2019). The participant researcher believed that decreasing cognitive load and taking advantage of gestalt processes of visual perception would alleviate some of the difficulty associated with comprehending and/or composing complex arguments (Bell, 1997; Clark, R. et al., 2006; Haller, 2010; Harrell, 2005a & b; Hyerle & Yeager, 2007; Suthers, 2014). The participant researcher was very pleased with the progress made by the participants of this study and plans to continue the use of argument mapping with future students. However, this study's intervention was unable to eliminate task avoidance in a small population of students, the very students she most hoped to impact. On reflecting upon the results of the present study, the participant researcher became aware of aspects of the problem of practice and the study's intervention that she had not previously considered, such as the neuroscience of Type 1 and 2 cognitive processing and the essential nature of critical thinking dispositions to the development of critical thinking skills, and continued to review relevant literature to develop an action plan.

Explicit Direct Instruction (EDI) in Critical Thinking (CT) Is Necessary

That EDI is necessary to CT instruction was rather a lesson confirmed than a lesson learned, yet there were reasons for its truth of which the participant researcher had

been unaware. Cognitive research has proposed that the brain has two options for problem solving, Type 1 and Type 2 processing (Eigenauer, 2015; Evans & Stanovich, 2013; Paivio, 2014). Type 1 processing is associated with cognition needed for survival and makes decisions quickly, basing decisions upon emotion or instinct. The brain has a natural, evolutionary tendency to default to this form of processing. Engaging Type 2 processing, slower, more effortful CT, requires conscious effort, dispositions that prompt a person to choose deliberative cognition over instinctive cognition. Because CT is not a natural tendency, it must be taught (Eigenauer, 2015: Evans & Stanovich, 2013; Paivio, 2014). In reality, the human brain is already capable of CT abilities even without instruction, so what is thought of as instruction in CT is really the action of making a student aware of the cultural norms associated with CT, such as the expectation that claims be supported with evidence or the necessity of considering opposing ideas (Facione, 1990). The Rationale tutorial provided well-designed, self-paced, explicit, incremental instruction, yet not all participants were successful. The participant researcher has long observed the negative behaviors of task avoidance, refusal to engage in deep critical thought, or the inability to sustain adequate cognitive effort over time, and attributed such behaviors simply to laziness. However, there may be slightly more to it than an apparent lack of work ethic or even a lack of cognitive ability.

Self-Directed Learning Adds to Cognitive Load. Self-directed study contributes to cognitive load in that students must use cognitive resources and dispositions (i.e., working memory and persistence) for self-management of attention, self-direction of learning by selecting appropriate activities, and information literacy in choosing necessary and relevant learning resources, all in addition to learning the actual material

(Facione, 2000; Sweller, 2019). Writing from sources is commonly a self-directed enterprise, much as the tutorial and applied practice aspects of the present study's intervention. This is not to say that self-regulated learning is a poor method. In fact, the ability to choose the materials and pace of learning can be motivating, and it certainly fosters dispositions that will lead to competent independence later in life (Bandura, 1977, 1989, 1997; Deci & Ryan, 1985, 2002; Flowerday & Schraw, 2003; Flowerday & Shell, 2015). However, the effectiveness of self-regulated learning depends upon how much working memory a task requires and how much working memory a student has available after allocating the necessary cognitive resources to self-regulation tasks (Clark, R. et al., 2006; Sweller et al., 1998, 2019). Students who have mastered cognitive task regulation to the point of automaticity require less working memory to engage that ability, freeing up working memory to attend to the learning task; whereas, the brains of students who are less adept at cognitive task-switching will forgo the advantage of consulting supplementary materials in order to preserve working memory for the learning task itself (Clark, R. et al., 2006; Sweller et al., 1998, 2019). While the participant researcher had ensured that students were provided with explicit and direct instruction, what some students may have required was direct*ed* instruction because they had not developed the CT dispositions and skills required to metacognitively monitor their learning and make use of the appropriate scaffolds provided.

Kuhn (2005) contends that dialectic is an effective method for initiating argumentation skills. De Fuccio et al. (2009) applied Kuhn's sequence of argument skills development with 52 adolescent males from in a juvenile detention facility provided an example of how EDI in the form of cognitive apprenticeships was able to counter poor

academics and poor CT dispositions to allow students to engage in dialectic conversation when told explicitly what cognitive move to make and why it needed to be made. Prior to the first instruction session, participants accessed prior knowledge by completing a survey on the topic of capital punishment, receiving a formal definition of capital punishment, and indicating whether they were for or against capital punishment. Students' responses were used to assign small groups. An instructor worked with a small group of three to five students eleven times over a six week period to guide students through the process of generating an argument to be debated with an opposing side. Students were led through the following tasks, one task per session: generating reasons, elaborating reasons, evaluating reasons, supporting reasons with evidence, developing reasons into an argument, examining and evaluating the opposing side's reasons, generating counterarguments to others' reasons, generating rebuttals to others' counterarguments, contemplating mixed evidence, and conducting and evaluating two-sided arguments, and engaging in formal debate. The instructor would walk the group through each step of the process, drawing their attention to what they should consider next and to what dispositions they were using. In each session, the instructor was careful to offer no more than one idea at each stage of the process, and only if the students had made a glaring omission of essential information. The students, who were approximately five or more years behind their peers in reading comprehension, were able to engage in civil oral debate by the end of the intervention, and to transfer the dispositions and skills they developed to real-life interactions with peers and adults. Facility staff reported observing the boys being less impulsive, more articulate, and more willing to listen to others' perspectives after engaging in De Fuccio et al.'s (2009) guided dialectic activities.

The participants in both the present study and De Fuccio et al. et al.'s study were presented with good materials, appropriate tasks, and the freedom to collaborate; the difference was in the level of direction and the required collaboration.

CT Dispositions Are as Important as to Develop as CT Skills

Because Type 2 cognitive processing requires a disposition to engage and persist in effortful CT, many scholars believe that skills cannot be developed without the accompanying dispositions (Bailey, et al., 2019; Eigenauer, 2015; Facione, 2020; Halpern, 2014). Though scholars differ in the amount of structure they believe should be imposed upon CT curriculum, many agree that one learns best by doing and by being made explicitly aware of the skills and dispositions that one is, or should be, utilizing (Bailey, et al., 2019; Eigenauer, 2015; Facione, 2020; Halpern, 2014). Bailey et al. (2019) increases awareness through the use of a CT dispositions and skills self-assessment tool. The tool provides awareness of the attitudes and cognitive moves required of critical thinkers such that students are more likely to engage in them, which increases feelings of self-efficacy, which will then foster a desire to engage in a develop those dispositions and skills even further. Bailin et al. (1999a & b) warn against the tendency to reduce something as complex as CT to a list of discrete skills or a process checklist, preferring to conceive of CT as a way of being into which novices need to be initiated through guided experiences in dialectic and inquiry. They suggest that CT development takes a long time, so it needs to begin early with dispositions being even more important to develop than skills in the elementary grades. Halpern (1998, 2014) advocates making students explicitly aware of the skills and dispositions they engage in and structuring practice such that students experience the use of a skill or disposition in

various ways to ensure transfer to real-life contexts. Kuhn (2005) insists that telling students that certain dispositions or skills are valuable is not enough to engender their adoption; students must experience the power and usefulness of those skills and dispositions for themselves. Kuhn advocates for providing students with many varied opportunities to engage in inquiry and argument for which the students have a purpose more genuine than mere assignment completion. She suggests that the desire to win is a strong motivator for effortful work, as evidenced by the effort the De Fuccio et al.'s (2009) participants put forth to win their debate. They have to care about the issue in order to be willing to engage in the hard work that CT requires. Kuhn suggests that experiencing the power of CT to help one achieve success will have a better chance of motivating students to adopt CT skills and dispositions than teachers' exhortations.

Time Is a Crucial Factor

Time for Long-Term Development. If CT is a combination of ability and disposition, it must follow that its development is affected by a person's psychological development over time as in the case of adolescents whose dispositions are still in flux (Erikson, 1968). van Gelder (2005) acknowledges that the development of CT skills is "more of a lifelong journey than something that can be picked up in a two-week module" (p.42). CT instruction should be incorporated throughout the K-12 curriculum, beginning with an emphasis on fostering CT dispositions in the elementary grades (Facione, 2000, 2020; Kuhn, 2005). Block scheduling has cut the time secondary teachers have with students in half. On a four-by-four block schedule, students have half the time to effect a year's worth of growth. While block scheduling does have benefits such as increasing the number of classes students have an opportunity to take and increasing four-year

completion rates, the time to develop is sacrificed to bigger-picture logistics. However, such policies are beyond the day-to-day control of classroom teachers who must not abnegate the responsibility to instill such essential aspects of one's education. The participants in this study had only six weeks to enhance their CT skills before the posttest. Six weeks is a very short time when compared to the semester-length CT courses offered to university-level students in other studies (Bacig et al., 1991; Butchart et al., 2007; Carwie, 2009; Carrington et al., 2011 Twardy; 2004). Gains were achieved during this short amount of time, but at the expense of task fatigue and the effect of relatively massed practice when compared to an 18-week semester. One way to counteract this shorting of class time is to emphasize CT as a curriculum-wide imperative across years and subjects (Facione, 2020, Halpern, 2014; hooks, 2010; Inouye & Houseal, 2018; Kuhn, 2005). This variety would also have the benefit of fostering cognitive flexibility as students experienced CT in different contexts with different purposes.

Time for Short-Term Development. The short time frame of this study required students to work diligently for thirty minutes to an hour every day for six weeks in order to complete the pretest, the tutorial, the applied practice, and the posttest. The only other tasks assigned for this class during the intervention were daily vocabulary lessons and supplemental reading assignments for a novel study. Despite Rationale's pleasing interface and the elimination of the essay-writing component, during week three of the intervention (the second week of the online tutorial) and week five (the second week of the applied practice), even students who had been successful and interested in the program began to show signs of fatigue and resignation to the task rather than the interest

and optimism they had shown previously. Twardy (2004) also noted such fatigue in his work with university students. Week four mitigated some of the fatigue as the task changed from the short tutorial lessons to the full-length articles of the applied practice assignments. However, the relief lasted only until the task was repeated in week five. Task variety can improve learning outcomes by maintaining interest and by providing points of comparison that can deepen understanding (Kuhn, 2005; Sweller, 2019). Sweller (2019) suggested that this sort of fatigue may represent another aspect of cognitive load in that the fatigue of longer sessions may deplete available working memory, resulting in a point of diminishing returns.

Providing more space between practice sessions would allow participants' brains the time and sleep required to transfer learning to long-term memory more effectively (Born & Wilhelm, 2011; Dean & Kuhn, 2006; Sweller, 2019). Extending the duration of the unit such that students spend less time each day engaging in argument mapping, or incorporating small argument mapping assignments into various units of study, might allow students to experience the positive aspects of routine and familiarity while avoiding the burnout caused by the intensity and repetition of the intervention. Spacing practice sessions across an extended period can also accommodate students who require more time to progresses than their peers. The participant researcher's desire to incorporate more whole- or small-group EDI with the Rationale tutorial would not preclude allowing students to progress at their own pace if extra EDI tutorial sessions were offered to students who might need a lesson to be repeated because they were not fully ready to process the material when it was presented to the larger group.

Time for Feedback. Twardy (2004) Landis et al. (2007) and Butchart et al. (2009) have mentioned difficulty in providing detailed feedback in a timely manner. It is a complicated thing to interpret students' maps not only for accuracy and completeness, but to identify errors in reasoning, and to explain those errors to a student along with suggestions as to how to avoid such errors in the future. Brief written notes are often too vague to be effective, and longer, more detailed notes are too complex to understand without accompanying discussion. Therefore, short meetings involving short specific notes and verbal elaboration provided the most satisfactory experience for both the participant researcher and the participants (Cabot & Kaldestad, 2019; Salamone, 2019). Though such meetings require much more time than disseminating brief written feedback, the opportunities for teachable moments warrant the time. Extending the length of the instructional time frame would allow for such feedback sessions before students continued with a subsequent exercise. An example of such a session appears in the Implications for Practice section of this chapter.

Limitations of the Study

It is important to note that the aspects of argumentation addressed in this study were limited to analyzing expert arguments and presenting that analysis in argument map form and constructing argument maps of original arguments supported by expert source documents. Selecting sources, evaluating the strength of an argument, and composing an argumentative essay, to name only a few argumentation skills, were purposely not addressed. As classroom action research, this study's findings cannot be construed as representing any group beyond its participants. The lack of a control group limits the confidence with which the intervention can be said to have caused the effect observed in

the posttest. The lack of a standardized measurement instrument precludes the direct comparison of the results of this study to any other study. Due to the fact that the posttest consisted of a task identical to the tasks assigned during the practice portion of the intervention, it can be said that the intervention's effects were mere practice effects. However, for the participant researcher's purpose of finding a way to improve the comprehension of and composition of arguments through targeted practice of CT skills, even a mere practice effect would have been a desirable outcome. The purpose of this study was not to make the facile declaration that practice makes perfect, but rather to provide practitioners with an option for integrating the incremental practice of specific CT skills, analysis, synthesis, and organization, without the burden of multiple full-length essay assignments or the confounding variable of concurrent writing skills development.

Implications for Practice

This study has provided evidence that it is possible to develop the CT skills necessary for argumentative writing from sources without full-fledged research paper assignments, particularly ones too large to be repeated the multiple times at the regular intervals required to achieve proficiency in those skills. The time required to engage in an effective amount of practice and to provide the necessary feedback suggests that argumentative research assignments cannot be relegated to single units limited to a few weeks (Artman et al., 2010). Rather, the development CT skills must become a daily part of all subjects in the curriculum throughout the length of a course and integrated into all units of instruction in order for students to see the transferability of CT skills beyond the research paper (hooks, 2010; Inouye & Houseal, 2018). Providing purposeful, authentic opportunities for inquiry and argumentation can help students experience the usefulness

of CT skills and dispositions for themselves. Collaborative EDI sessions in the process of argument (De Fuccio et al., 2009; Kuhn, 2005) can provide such experiences, as well as support to students who may not have adequate facility in cognitive task-switching during self-directed learning. With collaborative EDI sessions and dialectic, feedback could be more instantaneous, although, the logistics of making time for multiple small groups would be a challenge.

The constraints of the present study did not allow for extensive development of students' arguments beyond the limits of the provided material. However, in the interest of providing colleagues with examples of ways to infuse the curriculum with many small opportunities for instruction in CT, Figure 5.1 contains an example of how the participant researcher would have guided the student's, or the entire class's, thinking in revising the original map (see Figure 4.2) had the scope of the assignment included performing additional research and gaining even deeper knowledge of the subject matter. Notice in the second co-premise (far right) of the supporting evidence (green) that the student needed correction in reading comprehension. The student erroneously paraphrased the original words *up to* as *at least*, thereby obscuring the author's meaning. Such a mistake is easily made by a novice and provides an object lesson in precise word choice. Notice also in that same box the qualifier *can* indicating that Bt toxin does not always remain active for 234 days. The participant researcher would have drawn the student's attention to that qualifier and prompted the student to question the logic of using an extreme measure as opposed to a population average. These lessons would have the benefit of fostering cognitive dispositions of precision and intellectual integrity (Facione, 2000).

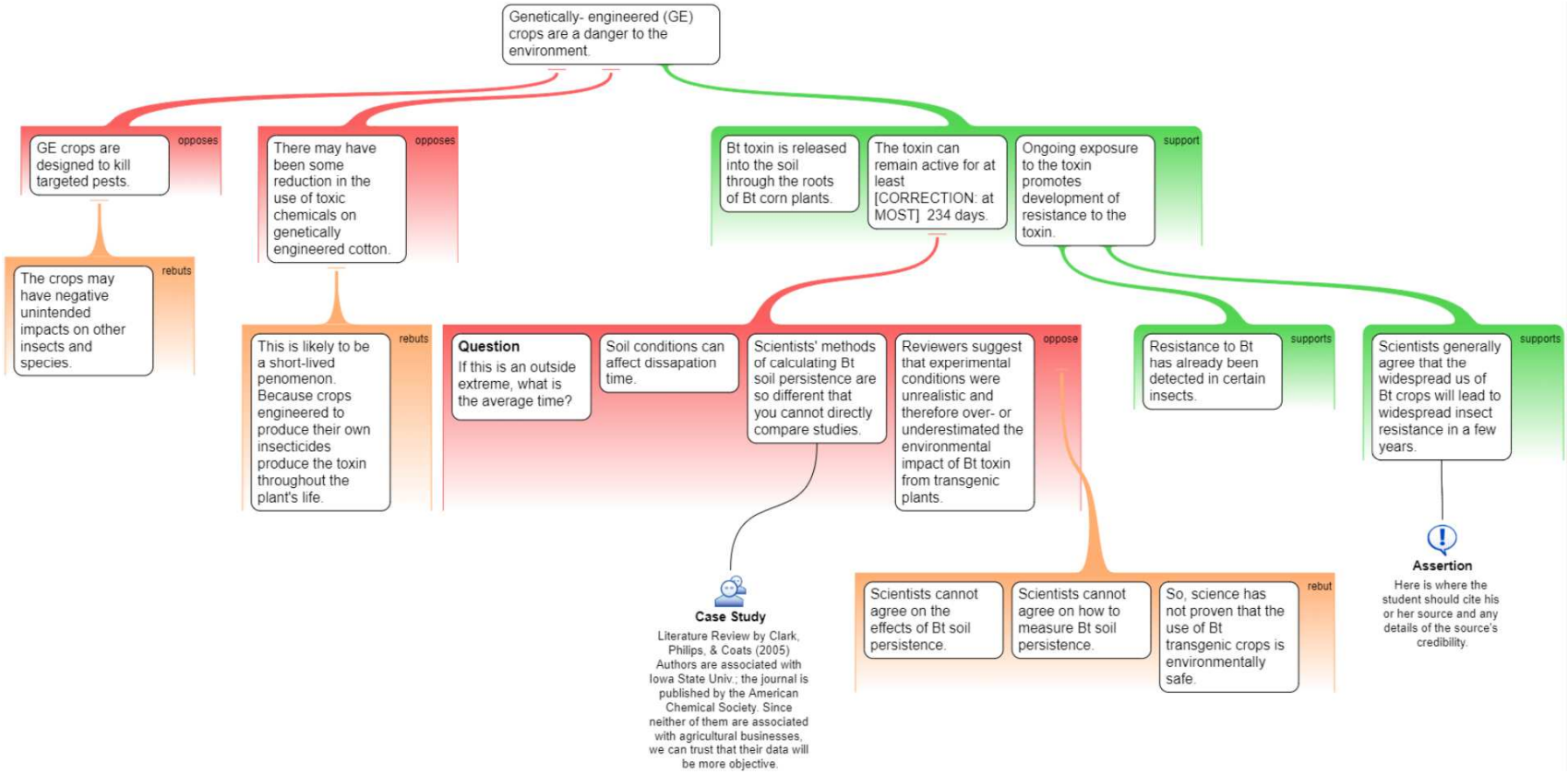


Figure 5.1 Participant Researcher's Revision of Figure 4.2

A single Google search for *bt toxin half-life* yielded a scholarly literature review of studies on Bt soil persistence (Clark, B. et al., 2005) that would have provided a teachable-moment for reading instruction on the use of textual cues to navigate scholarly research, particularly the use of abstracts, charts, and subheadings. A skim of just those portions of the article, the abstract, one chart, and the conclusion, revealed the difficulty of determining the average rate of Bt toxin dissipation due to the vastly different methodologies and settings used in the studies. The scholarly literature review concluded that future research should focus upon developing more consistent methodologies to determine the dissipation rate of Bt toxin. In Figure 5.1, the red boxes opposing the idea, "The toxin can remain active for at most 234 days," represent the questions and information that would have been generated in an individual or whole-group conference session addressing the revisions just described. The student's acknowledgement that scientists could not even agree upon how to measure the soil persistence of Bt toxin concedes a weakness of the student's original supporting evidence while still furthering the student's main contention by establishing that scientists have not established conclusively the impact of Bt crop engineering.

A critique of this one element of this small argument map has provided opportunities for the development of dispositions and abilities essential to CT and the acquisition of subject knowledge relevant to the issue under consideration. The skill of reading comprehension was addressed through semantic analysis of the use of *up to* as opposed to *at least*. The disposition of courage and the ability to make a logical inference were addressed by encouraging the student to question the author's use of extreme data to support a conclusion (Hitchcock, 2018). The disposition of a habit of inquiry and the

skills of generating research questions and consulting sources were addressed by wondering about and searching for the information *not* provided by a source article, the average Bt dissipation rate (Hitchcock, 2018; Kuhlthau, 1994). Guided practice via a read-aloud walk-through of that article would foster students' courage, to use Hitchcock's (2018) term, in their ability to handle such texts by showing them strategies for gleaning accurate information from a text that would otherwise be too daunting (Hollingsworth & Ybarra, 2009; Vygotsky, 1978).

Action Plan

Based upon the findings in this study, the participant researcher will continue to employ argument mapping as an integral part of her curriculum. Based upon the research advocating the use of collaboration with argument maps (Butchart et al., 2009; Heglund, 2015; McGuire, 2010; Reznitskaya et al., 2007), the participant researcher plans to employ more group work and dialectic. The participant researcher also plans to provide more EDI lessons, with an emphasis on direction and checking for understanding, to help students who fail to thrive under self-regulated conditions (Hollingsworth & Ybarra, 2009). Table 5.1 details the scope and sequence of the participant researcher's future argumentation curriculum, which will span the entire semester. The participant researcher will survey students to determine appropriate topics with which students have some familiarity in order to maintain student interest and to eliminate a lack of background knowledge or reading comprehension as a source of extraneous cognitive load (Kuhn, 2005; Leckie, 1996). Four argument inquiry sessions will be conducted over the course of the semester. Note the move toward skills transfer with the inclusion of prose writing from student-generated argument maps. Other aspects of researched argumentation (i.e.,

citation, source evaluation, etc.), though not specifically mentioned, would still be covered in mini-lessons, but the focus would remain on the development of CT skills.

The weeks 1-4 session will use Kuhn's (2005) structure (see the Self-Directed Learning Adds to Cognitive Load section of this chapter) addressing one skill per half-hour session, three times per week. Session will be conducted using EDI for the whole group until session six when the group is divided into opposing groups at the point of examining and evaluating the opposing side's reasons, at which point the participant researcher will continue to conduct EDI lessons with each group separately (Hollingsworth & Ybarra, 2009). A debate will be held at the end of week four. The weeks 5-8 session will repeat Kuhn's process in small groups (two halves of the class that will be divided again by pro or con stance) with the participant researcher directing the process by reminding groups what cognitive tasks they should be attending to and monitoring groups' efforts. Debates will be held at the end of week 8.

Table 5.1 Action Plan Intervention Schedule

Duration	Instructional Units
Weeks 1-4	Whole group argument planning & debate
Weeks 5-8	Small group argument planning & debate
Weeks 9-10	Writing prose arguments from argument maps
Weeks 11-14	Small group argument planning & group prose argument
Weeks 15-18	Pair argument planning and individual prose argument

During weeks 9-10, students will develop their arguments into prose essays. With the input of the whole group, the participant researcher will model the process of using one of the previously-created argument map from weeks 1-4 to compose an argumentative essay. As the participant researcher models, students will create their own copy of the group essay in order to remain engaged and to practice using the Rationale and word processing software efficiently to transfer ideas from the map to the essay. Small groups will repeat the process to compose a group essay in week 10 using any of the other three maps created in weeks 1-4 or 5-8. After scoring the essays, the participant researcher will model evaluating an anonymous argument from another class using Facione & Facione's (1994/2011) Holistic Critical Thinking Scoring Rubric (see Appendix I). The participant researcher will model collecting evidence to justify the choice of a score. Individuals will then assess a different anonymous essay and compare those evaluations with a small group of peers to come to a consensus. The class will then be brought back together to compare their assessment with the participant researcher's assessment. This process will provide practice in argument analysis and will help students to more deeply understand what is expected of them when writing essays. During weeks 11-14, small groups will return to argument construction culminating in a group prose essay. The final session, weeks 15-18 will be conducted as the first three sessions, but with pairs, and will culminate with individual essays.

Implications for Research

The participant researcher plans to conduct further cycles of action research to determine how the use of a more faithful application of Hollingsworth and Ybarra's (2009) model of EDI to CAAM interventions with small groups impacts task avoidance.

The participant researcher also plans to study the effect of semester-long spaced-practice, as described in the Action Plan section of this chapter, on CT dispositions through a comparison of self-reported dispositions surveys and graded CT assignments. The current study used anonymous survey data, which precluded racially disaggregating data on attitudes towards research, argumentation, and CAAM. The participant researcher would like to conduct further research on African-Americans' perceptions of CAAM to explore reasons for the achievement gap between Whites' and African-Americans' performance on the current study's intervention. Further research is needed on the use of CAAM with high-school students across the curriculum, particularly on its effect upon the composition of prose arguments and scientific reasoning.

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APPENDIX A

QUESTIONS TO INCLUDE IN SELF-PREPARATION FOR TEACHER RESEARCH

Basic Questions about Research Purpose and Participants

- What is the purpose of this proposed research?
- What are my expectations of research participants?
- How will I make sure those I invite to participate understand the sincerity of my desire to give them complete freedom of choice to participate without penalty of any sort?
- How can I collect consent (from an adult responsible for each participant under 18) and assent (from participants themselves if under 18)?
- How can I honor the confidentiality of research participants and nonparticipants?
- What data do I plan to collect—audiotapes, videotapes, student work samples, journal entries, observations?
- Might a layered consent/assent form be useful, in which participants check levels of participation to which they agree, such as use of work samples, use of journal entries, use of audiotapes, use of digital video?

More Complex Questions about the Research

- How can I conduct member checks on my ongoing data analysis to make sure my understanding of meaning is confirmed by my participants?

- If I am working as part of a teacher inquiry community, how can I maintain participant confidentiality and still be part of the inquiry discussion?
- How can I make sure my research does not interfere with the academic mission of my role as a teacher?
- How will my participants and I understand the difference between the teaching/learning relationship and the researcher/participant relationship?

Ongoing Questions for Teacher Researchers Engaged in Self-Interrogation

- What is my place in terms of power? My students' place?
- How will I separate a student's participation as a research participant from her/his education as my student?
- How will I continue to ensure not only informed, noncoercive consent but also confidentiality?
- Who might be negatively affected by my research? How do I guard against negative impact (Brown, 2010, pp. 280-281)?

APPENDIX B

PRE-INTERVENTION ATTITUDE SURVEY

1. Students were asked to select three words that best described their feelings about research assignments. An alphabetical list of emotions with checkboxes accompanied the question.

bored	confused	frustrated	panicked
calm	discouraged	interested	pessimistic
clear-headed	energetic	optimistic	relaxed
confident	enthusiastic	overwhelmed	tired

2.-4. Students were asked to rank each of the three words they chose as being felt most strongly, less strongly, and least strongly.

5.-15. For questions five through fifteen, students rated on a four-point Likert scale their disagreement or agreement with each statement about research assignments.

Strongly Disagree Disagree Agree Strongly Agree

5. I enjoy research.

6. It is important to write a thesis statement before taking notes.

7. I am not sure what information to write when I take notes from sources.

8. Most of the time, I can easily understand the source documents I read.

9. I am unsure how to integrate sources (to incorporate within a single paragraph ideas on a topic from multiple texts to highlight how authors agree or disagree with others' perspectives).

10. I feel that citing sources is unnecessary.

11. I feel that citing sources is easy.

12. I feel confident in my ability to successfully generate documented research.

13. I feel confident in my ability to successfully present research in research paper format.

14. I feel confident in my ability to successfully present research in multi-media format.
15. I feel confident in my ability to successfully present research in oral presentation format.

16. Students were asked to select three words that best described their feelings about formal argumentation. An alphabetical list of emotions with checkboxes accompanied the question.

bored	confused	frustrated	panicked
calm	discouraged	interested	pessimistic
clear-headed	energetic	optimistic	relaxed
confident	enthusiastic	overwhelmed	tired

17.-19. Students were asked to rank each of the three words they chose as being felt most strongly, less strongly, and least strongly.

20.-26. For questions twenty through twenty-six, students rated on a four-point Likert scale their disagreement or agreement with each statement about formal argumentation.

Strongly Disagree Disagree Agree Strongly Agree

20. Formal argument is the same as informal argument.

21. Formal argument can be based solely on the author's opinion.

22. I enjoy engaging in formal argumentation.

23. Most of the time, I can easily understand the source documents I read.

24. I am uncomfortable contradicting others' opinions.

25. I feel confident in my ability to generate a researched argument.

26. I am not sure what information to look for when I analyze an argument.

N.B. This survey was anonymously administered via Google Forms. Therefore, the formatting of the quiz was slightly different from this document. You may access the survey at the following link: https://forms.gle/ B7A8JuPrScRQXsEYA

APPENDIX C

MID-INTERVENTION ATTITUDE SURVEY

1. Students were asked to select three words that best described their feelings about formal argumentation. An alphabetical list of emotions with checkboxes accompanied the question.

bored	confused	frustrated	panicked
calm	discouraged	interested	pessimistic
clear-headed	energetic	optimistic	relaxed
confident	enthusiastic	overwhelmed	tired

2.-4. Students were asked to rank each of the three words they chose as being felt most strongly, less strongly, and least strongly.

5.-15. For questions five through fifteen, students rated on a four-point Likert scale their disagreement or agreement with each statement about formal argumentation and CAAM.

Strongly Disagree Disagree Agree Strongly Agree

5. Formal argument is the same as informal argument.
6. Formal argument can be based solely on the author's opinion.
7. I enjoy engaging in formal argumentation.
8. I am concerned about offending others with my opinions.
9. I am uncomfortable contradicting others' opinions.
10. I feel confident in my ability to generate a researched argument.
11. I am not sure what information to look for when I analyze an argument.
12. I like using computer-assisted argument mapping.
13. I learned something new about formal argumentation from completing the guided practice in the interactive tutorial.

14. I feel more confident about my ability to analyze a formal argument after having completed the guided practice in the interactive tutorial.
15. I feel more confident about my ability to compose a formal argument after having completed the guided practice in the interactive tutorial.

N.B. These surveys were anonymously administered via Google Forms. Therefore, the formatting of the quiz was slightly different from this document. The survey may be accessed at the following link: https://goo.gl/forms/1R0FV01wdwTYaPEp1

The question “Most of the time, I can easily understand the source documents I read” was removed from the research section of the mid-intervention survey because the tutorial did not involve reading anything longer than one paragraph.

APPENDIX D

POST-INTERVENTION ATTITUDE SURVEY

1. Students were asked to select three words that best described their feelings *the upcoming* research assignment (posttest). An alphabetical list of emotions with checkboxes accompanied the question.

bored	confused	frustrated	panicked
calm	discouraged	interested	pessimistic
clear-headed	energetic	optimistic	relaxed
confident	enthusiastic	overwhelmed	tired

2.-4. Students were asked to rank each of the three words they chose as being felt most strongly, less strongly, and least strongly.

5.-15. For questions five through fifteen, students rated on a four-point Likert scale their disagreement or agreement with each statement about research assignments.

Strongly Disagree Disagree Agree Strongly Agree

5. I enjoy research.
6. It is important to write a thesis statement before taking notes.
7. I am not sure what information to write when I take notes from sources.
8. Most of the time, I can easily understand the source documents I read.
9. I am unsure how to integrate sources (to incorporate within a single paragraph ideas on a topic from multiple texts to highlight how authors agree or disagree with others' perspectives).
10. I feel that citing sources is unnecessary.
11. I feel that citing sources is easy.
12. I feel confident in my ability to successfully generate documented research.
13. I feel confident in my ability to successfully present research in research paper format.

14. I feel confident in my ability to successfully present research in multi-media format.
15. I feel confident in my ability to successfully present research in oral presentation format.

16. Students were asked to select three words that best described their feelings about formal argumentation *at this point*. An alphabetical list of emotions with checkboxes accompanied the question.

bored	confused	frustrated	panicked
calm	discouraged	interested	pessimistic
clear-headed	energetic	optimistic	relaxed
confident	enthusiastic	overwhelmed	tired

17.-19. Students were asked to rank each of the three words they chose as being felt most strongly, less strongly, and least strongly.

20.-30. For questions twenty through thirty, students rated on a four-point Likert scale their disagreement or agreement with each statement about formal argumentation *at this point*.

Strongly Disagree Disagree Agree Strongly Agree

20. Formal argument is the same as informal argument.

21. Formal argument can be based solely on the author's opinion.

22. I enjoy engaging in formal argumentation.

23. I am concerned about offending others with my opinions.

24. I am uncomfortable contradicting others' opinions.

25. I feel confident in my ability to generate a researched argument.

26. I am not sure what information to look for when I analyze an argument.

27. I like using computer-assisted argument mapping.

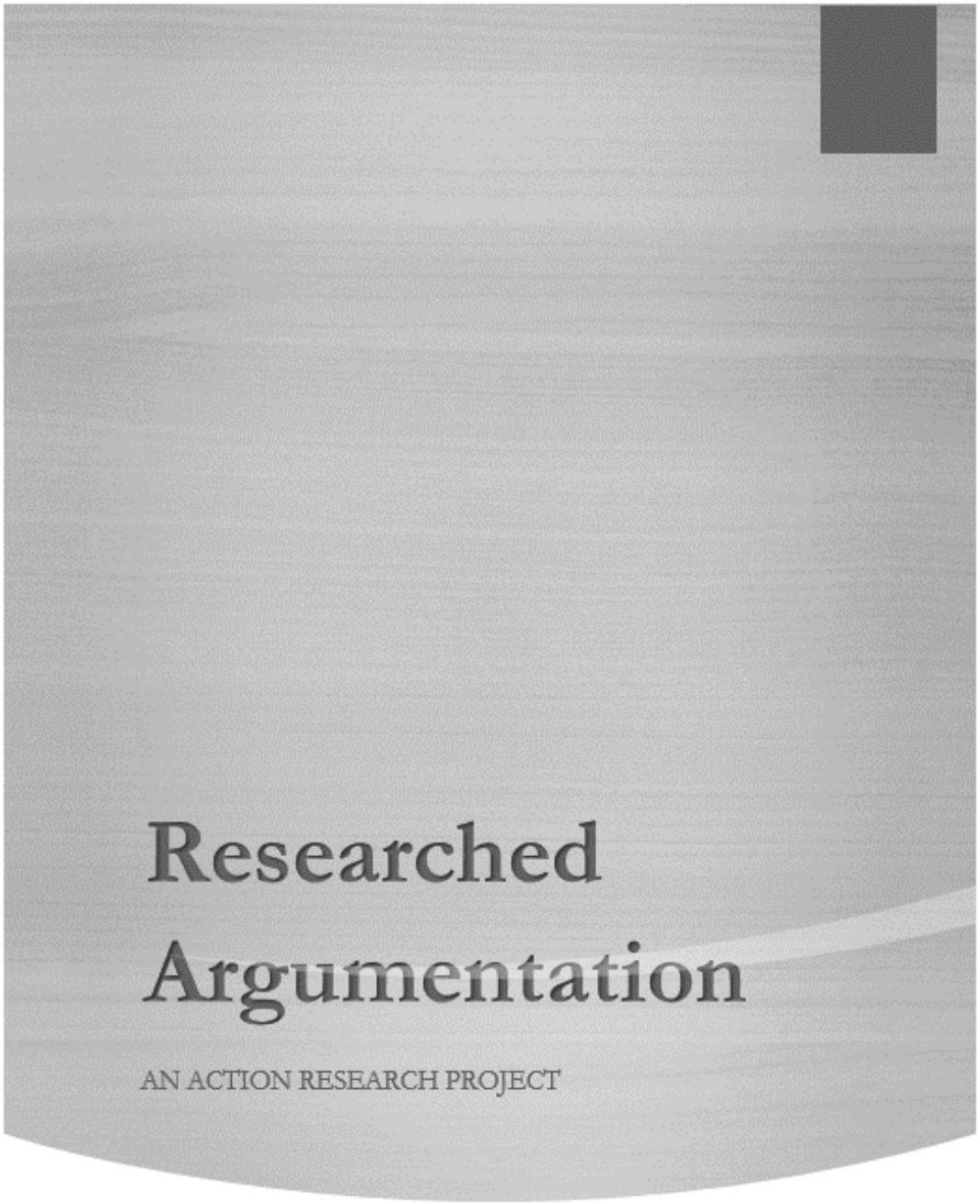
28. I learned something new about formal argumentation from completing the guided practice with full-length articles.

29. I feel more confident about my ability to analyze a formal argument after having completed the guided practice with full-length articles.
30. I feel more confident about my ability to compose a formal argument after having completed the guided practice with full-length articles.

N.B. This survey was anonymously administered via Google forms. Therefore, the formatting of the quiz was slightly different from this document. The survey can be accessed at the following link: https://goo.gl/forms/5mzemnxrxvsevli33

APPENDIX E

ARGUMENTATION UNIT PACKET



INTRODUCTION

Students,

This unit on argumentation is part of our regular curriculum. The focus of the action research project is to observe and describe the impact of one instructional tool that we will use to master the learning goals of the unit. Voluntary participation in the action research project involves simply allowing your data to be anonymously included in the data set and completing three anonymous surveys. Your participation is appreciated, but not mandatory. You will not hurt my feelings if you choose not to participate. However, you will still be expected to complete this unit of study.

PRETEST

The pretest has three parts that will be administered over the course of the week in addition to other instruction.

- A survey (research participants only)
- A performance task. Three quiz grades

You will receive participation grades for your work. No points will be deducted for errors. I encourage you to do your best work throughout the unit.

PRETEST INSTRUCTIONS

I. Go to our class on Schoology.

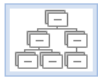
II. Research participants will complete the survey, which will take approximately 5 minutes, while non-participants will go on to the short-answer quiz.

III. Complete the performance task, which should take between 3 and 4 hours 40 minutes over the next 4 days:

1. You have been given five articles; one is an informative overview of a socioscientific issue, and the other four are argumentative texts that advocate for a particular aspect of the issue.
2. Read the informative overview to gain background knowledge that will help you understand the argumentative texts.

3. Skim the 4 argumentative texts and choose 2 of them to analyze. Make sure that you choose articles that have opposing perspectives.
4. Read a chosen article. As you read, look for the **elements of the argument**:
    i. The main contention (the main thing the author is trying to prove),
    ii. Reasons (why he believes as he does—more general),
    iii. Evidence (facts or examples that support reasons—more specific),
    iv. Counter-arguments (ideas opposed to the author's perspective), and
    v. Rebuttals (evidence that proves the counter-arguments wrong or unimportant)
5. You may use online resources to help you comprehend the source texts, but your argument may include information from the given sources ONLY.

TRY TO COMPLETE ALL TASKS TO THIS POINT BY THE END OF CLASS ON 9/4.

6. Present the author's argument graphically using a tree map:
    i. Open Microsoft Word.
    ii. Insert a hierarchy map, which you can find under the INSERT tab.
    iii. Find the Illustrations menu of the INSERT tab. Select Smart.
    iv. Select Hierarchy for the type of Smart Art.
    v. Then, select the graphic *named* "Hierarchy." Its icon looks like this: 
    vi. Set the page orientation to landscape.
    vii. Left-click the boxes to color-code them using the color code in #4.
    viii. How to organize your argument map:
        - The main contention is like a thesis and would go on the top tier.
        - Reasons, and possibly counter-arguments, of an argument are like the main points of an essay and would go on the second tier or below.
        - Evidence, and possibly rebuttals or even counter-arguments, are just like evidence in an essay and would go on the third tier or below.
        - For tier three or below:
            - Reasons should be connected to the belief above them that they support.
            - Evidence should be connected under the reason it supports.

    - Counter-arguments should be on the same level and connected horizontally ⟷ to whatever they contradict.
    - Supporting evidence or rebuttals should be connected under the counter-argument that they support or rebut.
- Do not forget to cite your sources within the text and to place quoted material in quotation marks. (Author's Last Name)

7. Save your document to Google Drive. Title it: Your last name-Pretest Map 1 (or 2).
8. Share your document with me, being sure to give me editing rights.
9. Go back to #4 and complete #'s 4-7 for the second article, which should present an opposing viewpoint. When you finish your argument map for the second article, move on to #9.

TRY TO COMPLETE ALL TASKS TO THIS POINT BY THE END OF CLASS ON 9/5, BECAUSE YOU WILL NEED *AT LEAST* TWO DAYS FOR #9.

---

10. Now that you have gained an understanding of your issue, take a position and
    i. Compose an argument to support your position. Include all **elements**.
    ii. Present your argument in a **color-coded** argument map in MS Word.
    iii. Cite from at least three of the argumentative texts. (author's last name)
    iv. Save your document to Google Drive. Title it: Last Name-Pretest Map 3.
    v. Share your document with me, being sure to give me editing rights.
    vi. Work should be submitted no later than Friday, September 8, at 3:25 p.m.

END OF PRETEST

INTERVENTION: PART I—SOFTWARE TUTORIAL

You have been asked before to read, analyze or compose an argument supporting a position. It may have been as short a task as providing evidence from a text to back up a statement about a literary work, or it may have been as long a task as preparing for an oral debate. However, you probably have not had practice specifically in argumentation. That practice is what the Rationale software tutorial will provide for you. You will have 10 school days between September 11 and 22 to complete the 10 modules of instruction at your own pace. You can access the site from home with an Internet connection. Feel free to work on the tutorials outside of school. Some modules are shorter, and some are longer. Below is a table of contents for the tutorials so that you can better budget your time. MASTERY is the goal. Do not push yourself through a module that you do not understand. If you find yourself averaging less than one module per day, let me know *that day*, and I will work with you.

Table E.1 Table of Contents for Rationale Tutorial

SET	TOPIC	# OF EXERCISES
1	GROUPING	4
2	ARGUMENT PARTS	5
3	INDICATORS	5 + QUIZ
4	REFINING CLAIMS	10 short exercises
5	LOCATING ARGUMENTS	4
~~6~~	~~ESSAYS~~	DO NOT COMPLETE
7	BASIS BOXES	3 + 2 QUIZZES
8	EVALUATING	6
9	MORE ON EVALUATING	2
10	ADVANCED REASONING MAPS	7
11	ADVANCED EVALUATION	4
~~12~~	~~A CHALLENGE~~	DO NOT COMPLETE

INTERVENTION: PART I INSTRUCTIONS

1. Please use your laptop to go to <www.rationale.com>.
2. Enter your information as stated on the slip of paper that I gave you with your account information on it.
3. On the Rationale homepage, scroll down to the Tools box and select Rationale Tutorials.
4. There are three sets of tutorials. You will be completing the Critical Thinking tutorial.
    i. There is a wealth of resources located in the left hand menu box that you can use in your study.
        - E-book (the software manual.)
        - Definitions/Glossary
        - Tutorials (feel free to use the other tutorials for information or additional practice)
        - Rationale Guide
        - Rationale Help
5. This is a self-guided, self-paced tutorial.
    i. Read the instructional material.
    ii. Complete the exercise.
    iii. Compare your answer to the model answer.
    iv. Go back and figure out why your answers were wrong and why the model is right. *This is where the learning happens.*
6. I will view your work via my teacher dashboard in Rationale. There is no need to print anything.
7. You will receive one daily grade for each completed module. Please let me know verbally when you finish each module.
8. Work must be completed by Friday, September 22 at 3:25.

After you complete all 10 lessons, research participants should complete the Mid-intervention survey on Schoology.

INTERVENTION: PART II—PERFORMANCE TASK

It was quick, easy, and possibly fun, to analyze the short arguments in the tutorial, but those short blurbs are nothing like the sources that you must use when writing research papers. Let's use your newly honed argument analysis skills to analyze arguments within full-length, published articles.

INTERVENTION: PART II INSTRUCTIONS

This performance task, should take between 3 and 4 hours 40 minutes over 5 days, September 25-29, with extra time for self and peer-grading of argument analysis maps. Each of the three maps is worth a quiz grade for participation. Points will not be deducted for errors.

1. You have been given five articles; one is an informative overview of a socioscientific issue, and the other four are argumentative texts that advocate for a particular aspect of the issue.
2. You may use online resources to help you comprehend the source texts, but your argument must contain information from the given sources ONLY.
3. Read the informative overview to gain background knowledge that will help you understand the argumentative texts.
4. Skim the 4 argumentative texts and choose 2 of them to analyze. Make sure that you choose articles that have opposing perspectives.
5. Read an article. As you read, look for the **elements of the argument**.
6. Present the author's argument in a Rationale argument map. You may use any of Rationale's resources to help you construct your argument.
    i. Do not forget to cite your sources within the text and to place quoted material in quotation marks.
7. When you finish, click the COPY button above the Workspace to create an image of your map.
8. Save that image to your Google Drive. Title it: Last Name-Intervention Map 1 (or 2).
9. Share it with me, being sure to give me editing rights.

COMPLETE TASK #'s 1-9
BY THE END OF CLASS ON MONDAY, SEPTEMBER 26, BECAUSE
WE WILL SELF & PEER ASSESS THEM ON TUESDAY, SEPTEMBER 27.

10. Go back to #4 and complete #'s 4-8 for the second article, which should present an opposing viewpoint. When you finish your argument map for the second article, move on to #11.

COMPLETE TASK #10 BY 3:25 p.m. TUESDAY, SEPTEMBER 27,
BECAUSE WE WILL SELF & PEER ASSESS THEM ON
WEDNESDAY, SEPTEMBER 28.

11. Now that you have gained an understanding of your issue, take a position and
    i. Compose an argument to support your position. Include all elements.
    ii. Present your argument in a Rationale argument map. You may use any of Rationale's resources to help you construct your argument.
    iii. Cite from at least three of the argumentative texts. (author's last name)
    iv. When you finish, click the COPY button above the Workspace to create an image of your map.
    v. Save that image to your Google Drive. Title it: Last Name-Intervention Map 3.
    vi. Share it with me, being sure to give me editing rights.

COMPLETE TASK #10 BY 3:25 p.m. ON THURSDAY, SEPTEMBER 28.
I'LL NEED TO GRADE THEM THAT NIGHT SO THAT YOU CAN HAVE FEEDBACK
BEFORE THE POST-TEST BEGINS ON MONDAY, OCTOBER 2.

END OF INTERVENTION

POST-TEST

The post-test has two parts that will be administered over the course of 5 days, October 2-6, in addition to other instruction. **This work will be graded for accuracy.**

- A performance task Three quiz grades
- A survey (research participants only

POST-TEST INSTRUCTIONS

Complete the performance task, which should take between 3 and 4 hours 40 minutes over the next 5 days. You have been given five articles; one is an informative overview of a socioscientific issue, and the other four are argumentative texts that advocate for a particular aspect of the issue.

1. Read the informative overview to gain background knowledge that will help you understand the argumentative texts.
2. Skim the 4 argumentative texts and choose 2 of them to analyze. Make sure that you choose articles that have opposing perspectives.
3. Read an article. As you read, look for the **elements of the argument**. You may use online resources to help you comprehend the source texts, but your argument must contain information from the given sources ONLY.
4. Present the author's argument in a Rationale argument map. You may use any of Rationale's resources to help you construct your argument.
    i. Do not forget to cite your sources within the text and to place quoted material in quotation marks.
5. When you finish, click the COPY button above the Workspace to create an image of your map.
6. Save that image to your Google Drive. Title it: Last NamePost-test Map 1 (or 2).
7. Share it with me, being sure to give me editing rights.

TRY TO COMPLETE TASK #'s 1-7
BY THE END OF CLASS ON OCTOBER 2.

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8. Go back to #3 and complete #'s 3-6 for the second article, which should present an opposing viewpoint. When you finish your argument map for the second article, move on to #9.

TRY TO COMPLETE TASK #6 BY THE END OF CLASS ON OCTOBER 3 BECAUSE YOU WILL NEED *AT LEAST* 2 DAYS FOR #9

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9. Now that you have gained an understanding of your issue, take a position and
    i. Compose an argument to support your position. Include all elements.
    ii. Present your argument in a Rationale argument map. You may use any of Rationale's resources to help you construct your argument.
    iii. Cite from at least three of the argumentative texts. (author's last name)
    iv. When you finish, click the COPY button above the Workspace to create an image of your map.
    v. Save that image to your Google Drive. Title it: Last Name-Post-test Map 3.
    vi. Share it with me, being sure to give me editing rights.
    vii. Work must be submitted by Friday, October 6 at 3:25 p.m.

After you complete the post-test, research participants should complete the Post-Intervention Survey on Schoology.

END OF POST-TEST & END OF UNIT

This packet also contained the rubrics located in Appendices G & H.

APPENDIX F

TREE MAP EXAMPLE

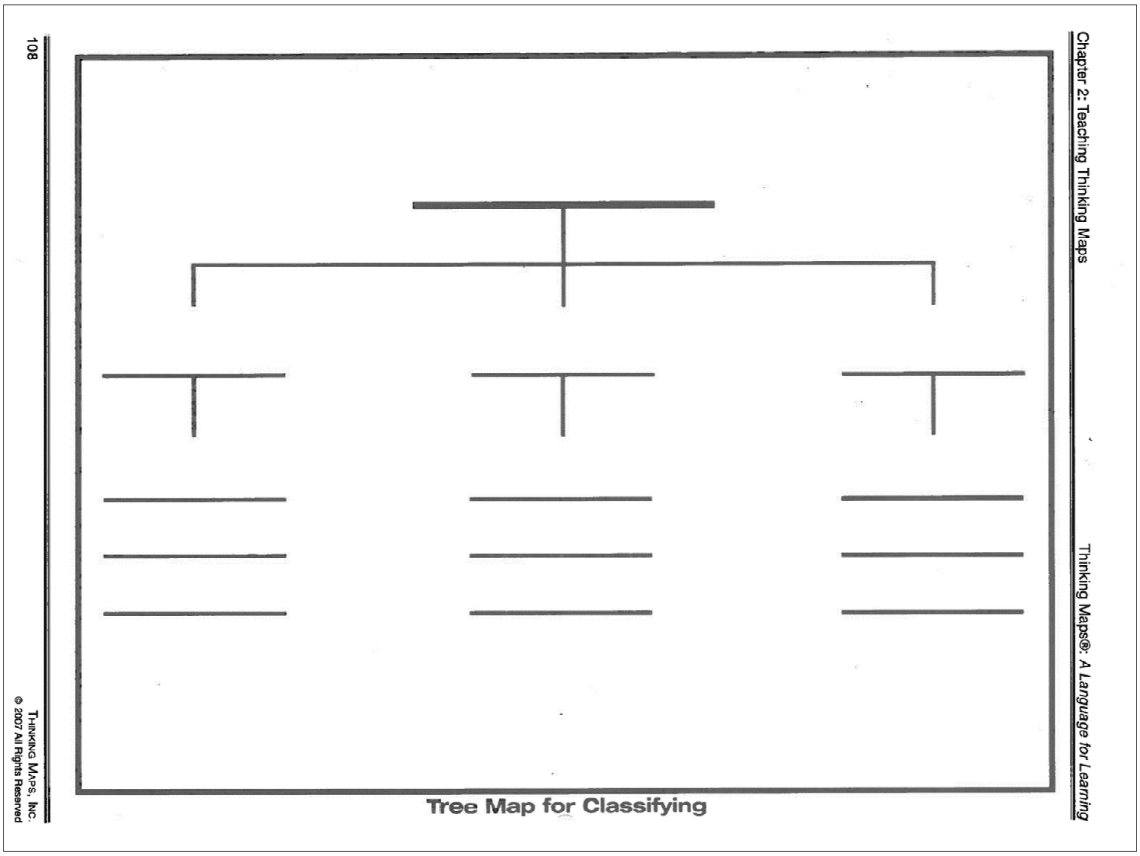

Figure F.1 Tree Map for Pretest

Note. From *Thinking maps: A language for learning*, by D. Hyerle and C. Yeager. Copyright 2007 by Thinking Maps. Reprinted with permission.

APPENDIX G

ARGUMENT ANALYSIS RUBRIC

Table G.1 Argument Analysis Rubric

	Proficient 4	**Progressing 3**	**Emergent 2**	**Unacceptable 1**
Main contention	correctly identified	2nd tier reason as contention	inaccurate	none identified
Reasons	most[1] are identified	some[2] are identified	inaccurate or insufficient[3]	none identified
Evidence	most[1] are identified	some[2] are identified	inaccurate or insufficient[3]	none identified
Counter-arguments & rebuttal	Counter-argument is accurately identified and accurately attached to appropriate reason & is disputed with a valid rebuttal.	Counter-argument is included and accurate, but is not placed near the reason it's countering. However it is disputed with valid rebuttal.	Counter-argument is included, but lacks rebuttal; or either is inaccurate.	none identified

Note 1 most is defined as 67-100% of what the author includes
2 some is defined as 34-66% of what the author includes
3 insufficient is defined as 33% or less of what the author includes

Table G.2 Scoring Data

ATTRIBUTE	POINTS EARNED
Main Contention	
Reasons	
Evidence	
Counterarguments & Rebuttal	
SUBTOTAL	
SUBTOTAL/4=SCORE	

Table G.3 Grade Scale

POINT AVG.	GRADE
4	100/A
3.75	96/A
3.5	92/A
3.25	89/B
3	86/B
2.75	82/B
2.5	79/C
2.25	75/C
2	71/C
1.75	68/D
1.5	64/D
1.25	61/D
1	57/F

APPENDIX H

ARGUMENT COMPOSITION RUBRIC

Table H.1 Argument Composition Rubric

	Proficient 4	**Progressing 3**	**Emergent 2**	**Unacceptable 1**
Main contention	The contention presents the author's position on a debatable issue by comparing/contrasting, proving cause/effect, or proposing a solution to an issue. Contention is effectively placed.	Contention attempts to present the author's position on a debatable issue. Contention is effectively placed.	Contention names the topic, but does not present a position on a debatable issue. Contention may be ineffectively placed.	No contention is discernable.
Reasons	Most reasons are valid and can be supported by evidence.	Multiple reasons are valid and can be supported by evidence.	At least one reason is valid and can be supported by evidence.	No accurate or relevant reasons are discernable, nor can they be supported by evidence.
Evidence	Most reasons are supported by accurate and relevant evidence.	Multiple reasons are supported by accurate and relevant evidence.	At least one reason is supported by accurate and relevant evidence.	No accurate or relevant evidence is discernable, or no evidence is provided.
Counter-arguments & rebuttal	A counterargument is well-placed near the appropriate reason and is disputed with a valid rebuttal.	A counter-argument is included and accurate, but is not clearly related to the rest of the argument.	Counter-argument is included, but lacks rebuttal, or rebuttal is invalid.	No counter-argument or rebuttal is included.

Table H.2 Scoring Data

ATTRIBUTE	POINTS EARNED
Main Contention	
Reasons	
Evidence	
Counterarguments & Rebuttal	
SUBTOTAL	
SUBTOTAL/4=SCORE	

Table H.3 Grade Scale

POINT AVG.	GRADE
4	100/A
3.75	96/A
3.5	92/A
3.25	89/B
3	86/B
2.75	82/B
2.5	79/C
2.25	75/C
2	71/C
1.75	68/D
1.5	64/D
1.25	61/D
1	57/F

APPENDIX I

HOLISTIC CRITICAL THINKING SCORING RUBRIC

INSIGHT ASSESSMENT

Measuring Thinking Worldwide

The Holistic Critical Thinking Scoring Rubric - HCTSR

A Tool for Developing and Evaluating Critical Thinking

Peter A. Facione, Ph.D. and Noreen C. Facione, Ph.D.

Strong 4: Consistently does all or almost all of the following:

Accurately interprets evidence, statements, graphics, questions, etc.
Identifies the most important arguments (reasons and claims) pro and con.
Thoughtfully analyzes and evaluates major alternative points of view.
Draws warranted, judicious, non-fallacious conclusions.
Justifies key results and procedures, explains assumptions and reasons.
Fair-mindedly follows where evidence and reasons lead.

Acceptable 3: Does most or many of the following:

Accurately interprets evidence, statements, graphics, questions, etc.
Identifies relevant arguments (reasons and claims) pro and con.
Offers analyses and evaluations of obvious alternative points of view.
Draws warranted, non-fallacious conclusions.
Justifies some results or procedures, explains reasons.
Fair-mindedly follows where evidence and reasons lead.

Unacceptable 2: Does most or many of the following:

Misinterprets evidence, statements, graphics, questions, etc.
Fails to identify strong, relevant counter-arguments.
Ignores or superficially evaluates obvious alternative points of view.
Draws unwarranted or fallacious conclusions.
Justifies few results or procedures, seldom explains reasons.
Regardless of the evidence or reasons, maintains or defends views based on self-interest or preconceptions.

Significantly Weak 1: Consistently does all or almost all of the following:

Offers biased interpretations of evidence, statements, graphics, questions, information, or the points of view of others.
Fails to identify or hastily dismisses strong, relevant counter-arguments.
Ignores or superficially evaluates obvious alternative points of view.
Argues using fallacious or irrelevant reasons, and unwarranted claims.
Does not justify results or procedures, nor explain reasons.
Regardless of the evidence or reasons, maintains or defends views based on self-interest or preconceptions.
Exhibits close-mindedness or hostility to reason.

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San Jose, CA. 95112-4511 USA
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Phone (650) 697-5628
FAX (650) 692-0141

Figure I.1 Holistic Critical Thinking Scoring Rubric

Note (Facione & Facione, 1994/2011)