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EFFECTS OF ELABORATIVE INTERROGATION AFTER READING BELIEF-INCONSISTENT ARGUMENTS AND NEED FOR COGNITION ON ARGUMENTATION AND TOPIC BELIEFS

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EFFECTS OF ELABORATIVE INTERROGATION AFTER READING BELIEF-INCONSISTENT ARGUMENTS AND NEED FOR COGNITION ON ARGUMENTATION AND TOPIC BELIEFS

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Constructing quality argumentation to justify one's own beliefs on a topic is important both for a thorough topic understanding and the development of argumentation writing skills. Also, one's change or retention of topic beliefs should be based on quality argumentation, such that the belief can be considered rational. The purpose of this study was to test whether a cognitive strategy, elaborative interrogation, can improve the understanding of belief-inconsistent arguments on a controversial topic and then improve argumentation quality, as well as result in reflective belief change. Elaborative interrogation is a cognitive strategy which prompts individuals to answer "why" questions on the to-be-learned information. The present study also examined the role of individuals' need for cognition in argumentation and its role in the relationship between using elaborative interrogation and quality of argumentation.

This study used a mixed model pretest-posttest experimental design with random assignment to three experimental conditions (elaborative interrogation treatment condition, summary control condition, and no-processing control condition) to test three hypotheses on effects of elaborative interrogation and need for cognition. It was hypothesized individuals who used elaborative interrogation strategy when reading

belief-inconsistent arguments would demonstrate improvement in quality of argumentation (Hypothesis 1) and reflective belief change (Hypothesis 2) after reading, whereas individuals who did not use this strategy would not. Argumentation quality and topic beliefs were measured before and after the experimental manipulation to examine pre-post changes, if any. It was also hypothesized high need for cognition would be associated with high quality of argumentation (Hypothesis 3). Based on the experimental results, Hypotheses 1 and 2 were confirmed. Hypothesis 3 was rejected.

In the end, implications of the findings about each hypothesis are discussed, along with possible cognitive mechanisms underlying these findings. Contributions of this study also are summarized, highlighting the connection between the psychology literature on cognitive biases and the education literature on learning strategies. Finally, limitations of the study are discussed, followed by suggestions for future research.

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CHAPTER 1

INTRODUCTION

Within the last decade, interest in argumentation has grown in the field of educational studies, with researchers examining argumentation from a number of different perspectives. One prominent emphasis has been to test whether certain interventions (e.g., goal instruction, use of graphic organizers and critical questions) improve the process of argumentation (e.g., Golanics & Nussbaum, 2008; Nussbaum, 2005; Nussbaum & Edwards, 2011; Nussbaum & Schraw, 2007). Studies have also been conducted on how students' individual differences affect the way they approach argumentation (Nussbaum, 2002; Nussbaum & Bendixen, 2003) and how argumentation can be utilized as an instructional technique conducive to content learning. (Nussbaum & Sinatra, 2003; Nussbaum, Sinatra, & Poliquin, 2008).

Most intervention studies on argumentation quality have used controversial topics as prompts for argumentation. Since a controversial topic usually involves complicated phenomena that are difficult to address empirically in a straightforward manner, arguments typically are proposed in such studies and made readily available for both sides of the controversy on the topic. In these studies, the quality of argumentation has most often been assessed with regard to how well individuals integrate arguments supporting their own stances on a topic with arguments contrary to their stances. Researchers seem to agree being able to coordinate supporting arguments and refuting arguments is essential to the construction of good argumentation and to the evaluation of arguments.

In the process of constructing argumentation to justify their own stances on the topic, however, individuals may integrate arguments supporting their stances and those refuting their stances at a surface level, or do so in a flawed manner. For instance, they may lack a sufficient understanding of an argument contrary to their stances and thus fail in constructing a valid rebuttal to it. They may also distort the meaning of such an argument thus making it easy to refute. In particular, if individuals already hold certain beliefs or take a side on the controversial topic prior to the integration of supporting and refuting arguments, argumentations they construct on the topic may be biased by their pre-existing beliefs or positions.

In the present study, argumentation was viewed as the cognitive foundation of individuals' positions and beliefs on a controversial topic. In other words, in the process of constructing argumentation, individuals engage in examining and articulating their beliefs on the topic. If provided with belief-inconsistent arguments on the topic, they may also engage in comprehending and evaluating these arguments. It is possible individuals' elaboration on their stances on a controversial topic will be affected by their understanding and evaluation of belief-inconsistent arguments. If their argumentations are constructed based on deep and unbiased information processing of belief-inconsistent arguments, it is likely their argumentations have sufficient validity as a cognitive basis for reflective belief change or belief retention.

This study examined whether a cognitive strategy could be used to remedy shallow and/or biased processing of belief-inconsistent arguments on a controversial topic such that argumentation could be improved after reading. Also, since argumentation may serve as the cognitive basis of the formation, change, and retention of individuals'

beliefs on a controversial topic (Kuhn, 1992, 1993), an understanding of arguments contrary to existing beliefs may affect the topic beliefs after reading. In particular, deep and unbiased processing of arguments refuting individuals' existing beliefs on the topic may change individuals' beliefs such that a more integrated and less extreme view is formed. Individual differences in cognitive motivation may also affect quality of argumentation and how well individuals react to the cognitive strategy for improving argumentation.

Quality of Argumentation and Belief-Inconsistent Arguments

Quality argumentation in both individual and social settings entails justifying and elaborating one's own position, as well as representing, understanding and responding to counterarguments. In educational settings, creating an argument can be either a solitary or social activity (Kuhn, 1991). When an argument is constructed solitarily (a rhetorical argument in Kuhn's sense, p. 12, 1991), one makes a claim on a topic and provides reasons and evidence to support it. The belief elaborated by reasons and evidence in the argument usually has competing alternatives. Therefore, a convincing argument in favor of one belief involves addressing other beliefs contrary to it. Without an account of alternative beliefs, an argument becomes fragile and even superfluous. When an argument is constructed in conversation with others (dialogic argument in Kuhn's sense), one is obligated to defend it against challenges and refutations from others holding competing beliefs by engaging in a debate. Without an integration of argument, counterargument, and rebuttal, such debate would be reduced to isolated presentations of competing beliefs without genuine communication between people taking two sides of the issue.

The technological age makes vast amounts of information available to students through various media, thus one can easily access arguments from various perspectives on a controversial topic. However, biased information processing may render the task of representing and understanding competing arguments challenging. Once individuals have decided to take certain positions on a controversial topic by holding some beliefs instead of others, the tendency of confirmation bias can result in ignorance or distortion of alternative beliefs and arguments supporting these beliefs (Arkes, 1991). Since quality argumentation entails integration of arguments and counterarguments, however, a sufficient and accurate understanding of arguments inconsistent with one's position may help one defend one's position on a topic with valid and convincing argumentation. Therefore, deep and objective processing of belief-inconsistent arguments is likely essential to the improvement of argumentation quality. The aim of this research was to test a cognitive strategy designed to improve argumentation by facilitating deep and unbiased processing of belief-inconsistent arguments.

Confirmation Bias and Its Cognitive Remedy

Confirmation bias is a generic term used to refer to a collection of different biases demonstrated in human reasoning. Although these biases can take various forms and have been demonstrated in a variety of task contexts, they all result in seeking or interpreting evidence in a way that confirms existing beliefs (Nickerson, 1998), rather than using the evidence to objectively examine the truthfulness of existing beliefs. Although a thorough explanation of the phenomenon of confirmation bias in all circumstances may involve both cognitive and motivational accounts (Kunda, 1990), three aspects of cognition appear to be critical to overcoming confirmation bias demonstrated in reasoning tasks

such as argumentation construction. First, individuals should understand the right way to show a hypothesis to be true is trying to falsify it, rather than trying to confirm it (Nickerson, 1998). Second, individuals should be able to represent beliefs/claims separately from evidence/reason for an assessment of whether the evidence/reasons have bearings on the beliefs/claims. Third, individuals should possess knowledge of formal logic and/or knowledge of probabilistic rules to reason soundly. Thus, an effective cognitive remedy to confirmation bias against belief-inconsistent arguments should be designed to improve one, some, or all of these three aspects of cognition.

Decades of psychological research on debiasing strategies has identified and tested a number of different cognitive strategies which can be utilized to correct reasoning flaws in judgment and decision making tasks in various contexts. Two of the most prominent of these are the "consider the opposite" approach and the "rule instruction" approach. The first approach is based on a questioning strategy which prompts individuals to reflect on possible reasons why their initial judgment or belief may be wrong. The second approach is based on explicit instruction on formal logic or probabilistic rules to improve reasoning performance (see Larrick, 2004).

Although the plausibility of these two approaches might appear to be self-evident, empirical studies have provided mixed evidence on their effectiveness. The "consider the opposite" approach, as reviewed by Schwarz, Sanna, Skurnik, and Yoon (2007), often fails to improve rational judgment because participants experience difficulty in generating belief-inconsistent alternatives and reasons. Schwarz et al. argue that such perceived difficulty may result in strengthening of the original belief, rather than weakening of it. In other words, the metacognitive experience of heavy cognitive load

imposed by producing belief-inconsistent content can actually "backfire" by making individuals less likely to consider such content.

As to the second approach—explicit verbal instruction of logical or statistical rules —its effects on reasoning performance have been found to be either mixed or limited (e.g., Evans, Newstead, Allen, Pollard, 1994). It is possible confirmation bias in part results from automatic processing such that individuals subject to confirmation bias are not aware of it. Therefore, it would seem the design of a cognitive strategy as a remedy for belief-based confirmation bias should consider (1) cognitive load induced by considering alternatives and (2) automatic processing that cannot be effectively overcome by explicit instruction.

Elaborative Interrogation as a Potential Remedy to Confirmation Bias

In the field of educational psychology, studies of learning strategies most generally have been motivated by a need for finding approaches that facilitate information processing for the purpose of content comprehension and retention. Among other strategies, elaborative interrogation particularly has been viewed as holding promise as a way of overcoming belief-based confirmation bias by facilitating deep processing of belief-inconsistent content.

Elaborative interrogation entails prompting learners to answer "why" questions on to-be-learned content, and has been found to be an effective strategy for improving learning of factual information (e.g., Pressley, Symons, McDaniel, Synder, & Turnure, 1988; Seifert, 1993; Willoughby, Waller, Wood, & MacKinnon, 1993; Woloshyn, Paivio, & Pressley, 1994). It also has been shown to be especially useful for associative-typed learning (e.g., Woloshyn, Willoughby, Wood, & Pressley, 1990), with elaborative

interrogation questions improving performance on matching tests with large effect sizes. More recently, research has revealed elaborative interrogation is also effective for improving inferential learning (e.g., Hannon & Daneman, 1998; Ozgungor & Guthrie, 2004; Paris & Glynn, 2004).

In the current research, elaborative interrogation strategies were adapted to make them more likely to serve as an effective remedy to confirmation bias against belief-inconsistent arguments. Specifically, an adapted elaborative interrogation intervention was designed to facilitate (1) representation of claims and evidence/reasons separate from each other; and (2) deep processing of associations between claims and the corresponding evidence/reasons. Such strategy intervention was judged to have the potential for improving argumentation that justifies one's position on a controversial topic after reading belief-inconsistent argument, as well as increasing the likelihood of topic belief change in less extreme and more balanced directions. These effects were considered likely because the adapted elaborative interrogation were judged as having the potential for improving the learning of belief-inconsistent arguments by combating confirmation bias against such arguments. Based on individuals' greater understanding of belief inconsistent arguments, they could be expected to better elaborate on their topic positions and beliefs. Chapter 2 provides a detailed review of literature on elaborative interrogation and confirmation bias by examining and connecting mechanisms of each.

The Role of Learners' Cognitive Motivation: Need for Cognition

In addition to the nature of materials and strategy intervention, students' individual differences in cognitive motivation may also be important in relation to the processes and outcomes of argumentation. Among such differences, students' need for

cognition—which has been shown to affect argumentation (e.g., Kardash & Scholes, 1996; Nussbaum & Bendixen, 2003)—may be an important variable to examine.

The concept of need for cognition was first proposed by Cacioppo and Petty (1982) as a cognitive motivation construct and defined as "the tendency for an individual to engage in and enjoy thinking" (Cacioppo & Petty, 1982, p. 116). Cacioppo and colleagues (Cacioppo & Petty, 1982; Cacioppo, Petty, & Kao, 1984) then developed and refined the Need for Cognition Scale (NCS) as a measure of this construct. Studies examining the psychometric quality of the NCS have provided evidence that it reflects a single dominant factor (Cacioppo, Petty, Feinstein, & Jarvis, 1996). Moreover, as an index of "stable intrinsic motivation" (Cacioppo, Petty, Feinstein, & Jarvis, p. 199) rather than a true need, need for cognition is both conceptually and empirically distinguished from constructs such as need for structure and need for closure.

In formulating their elaboration likelihood model, Petty and Cacioppo (1986) integrated need for cognition as a factor affecting processes and outcomes of persuasion. They portrayed need for cognition as a motivation to understand and construct meaning out of one's experiences. According to their model, individuals high in need for cognition are more likely to acknowledge the true validity of an argument as well as to detect the true defect of it, regardless of their own beliefs. In general, individuals high in need for cognition are more likely to engage in deep information processing (e.g., Sadowski & Gulgoz, 1996). In specific relationship to argumentation, individuals high in need for cognition are seen as more likely to engage in social argument (e.g., Nussbaum & Bendixen, 2003), which usually consists of intellectually challenging situations.

Psychological research on need for cognition, as measured by the Need for Cognition Scale (Cacioppo & Petty, 1982; Cacioppo, Petty, & Kao, 1984), has been quite extensive within the last 30 years. High need for cognition, for instance, has been found to be associated with high likelihood of processing information based on its true merits, which in turn leads to reflective belief formation/change and accurate learning outcomes (e.g., Kardash & Scholes, 1996; Mahoney & Kaufman, 1997; Nettelhorst & Youmans, 2012; Petty & Cacioppo, 1986; Vidrine, Simmons, & Brandon, 2007). Thus, it seems probable need for cognition is related to individuals' ability to construct argumentation for justifying their beliefs. Moreover, considering the likely effects of elaborative interrogation of facilitating deep information processing, need for cognition might interact with an elaborative interrogation experience in affecting individuals' tendency to engage in deep processing of belief-inconsistent arguments and their ability to construct argumentation of high quality after reading such arguments.

Research Questions

The present research focused on an examination of the effectiveness of elaborative interrogation strategy for improving argumentation on a controversial topic after reading belief-inconsistent arguments, and also examined whether such a strategy can change individuals' beliefs on the controversial topic toward a more balanced and less extreme direction. This research it further explored the effects of individuals' need for cognition on quality of argumentation and whether need for cognition interacts with the use of elaborative interrogation. Three questions were addressed by this research:

1. Does answering elaborative interrogation questions when reading belief-inconsistent arguments on a controversial topic improve quality of argumentation?

2. Does answering elaborative interrogation questions when reading belief-inconsistent arguments make participants' topic beliefs more balanced and less extreme?

3. Do individuals with different levels of need for cognition demonstrate different quality of argumentation and do they benefit differentially from use of elaborative interrogation for an improvement of argumentation?

Overview of Coming Chapters

Chapter 2 reviews relevant literature on the independent and dependent variables from the above research questions and their likely relationships. Chapter 2 also reviews two pilot studies and discusses methodological decisions on conducting the present research based on these results. Three research hypotheses are proposed following these reviews. Chapter 3 provides a detailed description of the methods used in the research. Chapter 4 presents experimental results corresponding to each research hypothesis and results of some additional analyses. Chapter 5 provides a discussion of the results, limitation of this study and suggestions for future research.

CHAPTER 2

REVIEW OF LITERATURE

The current chapter contains a review of literature relevant to the proposed study. First, the most prominent current research paradigms on argumentation are examined, leading to a discussion of argumentation as a basis of knowledge and reflective belief change in education. In particular, the chapter discusses how the process of argumentation and the resultant belief outcomes on a controversial topic may be affected by confirmation bias when individuals are exposed to information contrary to their beliefs. Second, the chapter provides a review of the literature on elaborative interrogation, primarily focusing on the cognitive mechanisms underlying effects of elaborative interrogation on learning. Psychological studies on confirmation bias are then reviewed for analyses of its connections with elaborative interrogation. Based on these analyses, the potential of elaborative interrogation as a debiasing strategy for facilitating processing of belief-inconsistent arguments is then discussed. Third, the chapter provides a summary of relevant literature on need for cognition as a basis for an examination of how this cognitive motivation construct may affect argumentation quality and interact with use of elaborative interrogation. Finally, the chapter describes two pilot studies conducted by the present writer relevant to methodological approaches to be utilized in the proposed study.

Paradigm of Argumentation Research

Argumentation research published in the field of educational psychology generally is aligned with two major paradigms, which in the current study are referred to

as an argument for comprehension paradigm and a comprehension for argument paradigm (Nussbaum, 2008a).

The argument for comprehension paradigm portrays argumentation as an instructional method to improve students' understanding and retention of content knowledge (e.g., Asterhan & Schwarz, 2007; Nussbaum & Sinatra, 2003; see also a review by Nussbaum, 2008b, on argumentation as pedagogy). This research paradigm treats argumentation as an independent variable and is mainly represented by argumentation research in science learning. For example, Asterhan and Schwarz (2007) experimented on effects of argumentation on conceptual understanding of evolution theory as measured by inference-type essay questions. Nussbaum and Sinatra (2003) likewise examined the effects of argumentation on the outcome of conceptual change learning. They found participants asked to argue for alternative explanation of a physics problem tended to reason better than those who approached the problem without argumentation. Both studies documented positive effects of argumentation on learning outcome.

In contrast, the comprehension for argument paradigm treats argumentation as a dependent variable and examines how skills of argument writing can be improved by strategies that solidify understanding of content specific to the argumentation topic. For example, Nussbaum (2008a) examined the effects of a graphic organizer on participants' use of argumentation skills. The graphic organizer in his study was designed for comparing argument and counterargument on controversial educational topics (e.g., whether school should mandate wearing uniforms) side by side. His study identified a number of argumentation skills such as integration of two sides on a controversial topic,

as opposed to pseudo-integration (e.g. simply restating the counterarguments). Argument-counterargument integration was found to be positively affected by training in use of the graphic organizer designed.

The current study adopted a comprehension for argument paradigm. Specifically, the main purpose of this research was to examine whether a cognitive strategy designed to improve understanding of arguments inconsistent with individuals' existing beliefs on a controversial topic can improve quality of argumentation constructed for justifying their positions on the topic.

Argumentation as the Foundation of Knowledge and Decision Making

As far as education is concerned, argumentation seems to play an important role in knowledge construction by representing the justifications on which individuals' beliefs are based. If students acquire beliefs after being exposed to information transmitted from the external world but are unable to argue for these beliefs, it is likely they are not engaged in active knowledge construction, even though the beliefs acquired are true. In addition, reasoning skills can be practiced through argumentation, which then contributes to the development of rationality. Thus, being educated, at least in part, means learning to construct and change beliefs by constructing and examining arguments (Kuhn, 2005, p. 178).

Quality of argumentation may also affect decision-making outcomes. For example, Kuhn, Weinstock, and Flaton (1994) examined individuals' reasoning processes and outcomes when they assumed the role of jurors. Participants in their study were asked to review evidence and videotapes of trials of a criminal case and to make decision about what verdict to choose. Kuhn et al. found two distinct modes of reasoning. The first is a

satisficing model, which some jurors deployed to generate a single story on "what happened" by drawing on some, but not other evidence. Although the story may have seemed plausible, there was evidence which could not be assimilated into the scenario of the story. In general, jurors endorsing a satisficing model ignored story-inconsistent evidence in order to keep the story unaffected and then chose a verdict which best matched the story. Other jurors reasoned based on a theory-evidence coordination model, in which they constructed multiple stories out of contradicting evidence. These jurors seemed to separately represent evidence versus stories. Since not all evidence fit with one story, the jurors had to evaluate each story by coordinating its supporting and opposing evidence as well as compare each story on the strength of supporting versus opposing evidence. The story evaluated as fitting best (but not perfectly) with available evidence was chosen and a verdict choice was then made.

In contrast to jurors endorsing the satisficing model, those endorsing the theory-evidence coordination model acknowledged the possibility of alternatives to the story they eventually chose. Also, jurors endorsing the theory-evidence coordination model construed the belief-independent status of evidence as containing truth in its own right without being incorporated into a pre-existing belief schema. In contrast, jurors endorsing the satisficing model simply considered consistent evidence as an integral part of the story they believed to be true and inconsistent evidence as "errors" (Kuhn et al., 1994), creating a biased argumentation. Thus, the theory-evidence coordination type reasoning represents a more rational process of argumentation, which is more complicated and objective than the satisficing type reasoning. Paradoxically, however, rational reasoners tend to be less certain about their beliefs as reasoning outcomes and readily acknowledge

the nature of beliefs as open to revision once new evidence is available (Kuhn, 1991). In the case of juror reasoning, jurors endorsing the theory-evidence coordination model also tended to hold less extreme views about what happened and therefore chose more moderate verdicts as compared with jurors endorsing the satisficing model.

Argumentation and Confirmation Bias

Definition and Research Paradigms of Confirmation Bias

In spite of its importance to knowledge construction and decision making, optimal argumentation does not seem to be the norm in academic or other settings. Studies in psychology and other related domains have documented a great deal of evidence on flawed human thinking in a variety of cognitive tasks. One category of such human reasoning flaws is referred to as confirmation bias. Confirmation bias manifests itself in a variety of forms and under various task structures including formal and statistical reasoning, and informal reasoning such as social judgment and decision making. Arkes (1991) defined confirmation bias as "…a selective search, recollection, or assimilation of information in a way that lends spurious support to a hypothesis under consideration."(p. 489) Similarly, Nickerson (1998) defined confirmation bias as "…the seeking or interpreting of evidence in ways that are partial to existing beliefs, expectations, or a hypothesis in hand" (p. 175).

In essence, confirmation bias means letting what one believes, looks forward to, or wants to prove drive the process of information selection, integration, and evaluation in a way that confirms, instead of tests, the pre-existing beliefs, expectations or hypotheses. In the case of argument reading, for instance, confirmation bias may lead to limited attention to reasons and evidence included in belief-inconsistent arguments, and

biased evaluation of the validity of the arguments. In the case of argument construction, confirmation bias may lead to neglect of alternative beliefs, and weighing supporting reasons or evidence more favorably than opposing reasons or evidence in order to preserve existing beliefs.

The presence of confirmation bias has been documented extensively in studies on human reasoning, basically under two paradigms differing at types of reasoning task used. The first paradigm uses a formal reasoning task which entails reasoning in abstract context using logic rules such as the Wason's Card Selection Task (e.g., Handley, Feeney, & Harper, 2002; Hardman, 1998), and 2-4-6 Task (e.g., Cherubini, Castelvecchio, & Cherubini, 2005; Gale & Ball, 2009) or statistical rules (e.g., probabilistic assessment tasks). In aggregate, findings on these tasks' performance have shown individuals tend to seek evidence or feedback that will confirm the hypothesis to be tested and thus paradoxically fail to test the hypothesis.

The second paradigm uses reasoning tasks embedded in social scenarios or social environment contexts which involve the formation and examination of "social theories" or "social judgment." These tasks ask participants to form beliefs about relationship between variables specific to hypothetical or real people in social context (Anderson & Sechler, 1986). Research findings have indicated people often tend to form premature beliefs quickly (e.g., Jones, Rock, Shaver, Goethals, & Ward, 1968), persist on initial beliefs which have been proved false (e.g., Ross, Lepper, & Hubbard, 1975), weigh evidence in a way preferable to existing beliefs (e.g., Pyszczynski & Greenberg, 1987), and fail to look for negative cases or consider the possibility of alternative judgments

(e.g., Chambliss & Garner, 1996; Fischhoff & Beyth-Marom, 1983; Hodgins & Zuckerman, 1993).

General Psychological Explanations of Confirmation Bias

Psychologists have proposed several accounts of confirmation bias. One approach to explaining confirmation bias is to pin down cognitive errors which cause confirmation bias. Arkes (1991), for instance, conceptualized three types of errors: strategy-based, association-based, and psychophysically based errors. Strategy-based errors prevail when individuals think the cost (time, effort) of being accurate outweighs the benefit of being accurate, or the benefit of being efficient (but inaccurate) outweighs the cost of being inaccurate and a less than optimal judgment or decision is made in order to be efficient. Association-based errors come from an association-based memory mechanism that underlies priming effects on information encoding and retrieval. Arkes has shown confirmation bias is caused primarily by association-based errors. He argued confirmation bias is a demonstration of the priming effects arising from pre-existing or pre-assumed (but untrue) association between two variables (e.g., the illusory correlation between personality traits and characteristics of drawings). Finally, psychophysically based errors have their origin in the innate non-linear relationship between physical intensity and psychological response and may be generalized to decision making situations to produce irrational behaviors.

An alternative approach to explaining confirmation bias is in terms of cognitive versus motivational accounts. Kunda (1990) extensively examined the empirical studies on confirmation bias with an effort to tease apart cognitive and motivational factors which contribute to confirmation bias. In Kunda's discussion of the distinction between

confirmation biases driven by deliberately self-serving reasoning versus those resulting from unrecognized limitations imposed by knowledge and beliefs, she noted motivational factors can play a role in confirmation bias even when individuals are unaware that their reasoning is biased by their beliefs.

From Kunda's (1990) analyses, it seems confirmation bias is related to both the individual tendency in information processing and environmental input. As far as individual tendency is concerned, Kunda has identified a dichotomy of goals as a motivational construct which can have great impact on reasoning process, namely an accuracy goal versus a directional goal. People endorsing the accuracy goal, she argues, will spontaneously reason on a more objective foundation by engaging in deep processing and using appropriate strategies as far as they can access such strategies. In contrast, people with the directional goal will tend to access prior knowledge and task information in a way preferential to the belief they want to argue for. People endorsing the directional goal also use biased inferential rules. She further noted directional goal-driven reasoners may perceive themselves as rational and objective, without an awareness of their biased memory search and rule accessing.

As far as environmental constraints are concerned, Kunda (1990) has argued a motivational account alone cannot sufficiently explain the phenomenon of confirmation bias, because even biased reasoners' reasoning seems to be constrained by the plausibility of the conclusion in relation to evidence or prior knowledge, as indicated by findings showing the variation of reasoning outcome as a function of task information. This is to say, individuals do not entertain an absolute freedom to argue at will for any conclusion they personally prefer. Thus, as far as using a strategy intervention as a remedy to

confirmation bias is concerned, an analysis of cognitive accounts of confirmation bias are likely to provide insights into mechanisms of confirmation bias and its potential correction.

Cognitive Accounts of Confirmation Bias

Edwards and Smith (1996) proposed a disconfirmation model to describe the asymmetry between cognitive processing of belief-consistent and belief-inconsistent arguments. They presented evidence from two experiments in support of a disconfirmation model interpretation. According to the disconfirmation model, people tend to exert more mental effort to examine belief-inconsistent arguments than belief-consistent arguments. Also, their approaches to dealing with these two kinds of arguments differ in that they evaluate belief-inconsistent arguments by accessing counterevidence from memory search, but do not do so for belief-consistent arguments. This model seems to be intuitively plausible and the four hypotheses it has generated have also been consistent with experimental results. However, two features of Edwards and Smith's experimental methods appear to leave these results open to other interpretations. One is their use of processing time as an indicator of deep processing, with longer time seen as reflecting deeper (yet biased) processing. The other feature is, their participants were asked to generate thoughts and arguments in response to each kind of arguments, with a larger number of thoughts and arguments seen as indicators of deeper processing.

It can be argued biased processing is not necessarily associated with long processing time. Instead, length of processing time might be a function of ease or difficulty of retrieving memory content. If counterevidence and counterarguments to

belief-inconsistent arguments can be easily accessed during memory search, one could reach a closure on evaluation within relatively short time. Thus, prior knowledge level and automaticity of memory association possibly mediate the relationship between processing time and to what extent the judgmental approach is biased.

Likewise, being able to generate more counterarguments does not necessarily reflect deeper and more thorough processing of the belief-inconsistent information per se. Admittedly, individuals on average would need to exert greater mental effort to generate more counterarguments to the belief-incompatible information than to generate fewer counterarguments to such information. However, individuals could easily focus on some perceptually prominent (but unimportant) detail (e.g. word usage) of such information and generate several refuting arguments to the detail, without genuinely examining the logical structure and evidence quality within such information. In addition to exerting great mental effort to refute belief-inconsistent information, ignoring or minimally processing such information can also serve the purpose of preserving existing beliefs.

Yet another cognitive account of confirmation bias has been examined in the work of Kuhn and her colleagues (Kuhn, 1991; Kuhn, Schauble, & Garcia-Mila, 1992; Kuhn, 2005) (although she seldom used the term “confirmation bias”). Kuhn, Schauble, and Garcia-Mila (1992) found some participants engaging in a scientific reasoning task manipulated independent variables to demonstrate their theory about the effects of these variables was true rather than to test their theory. For example, they manipulated multiple variables to create the condition which would most likely lead to the effects, whereas the correct method to test a theory is to vary the level of one variable at a time while keeping levels of other variables constant. These participants may not have realized the first

approach is subject to confirmation bias and thus not a productive way to test a theory. They also might not realize there could be a different approach. To construct unbiased arguments, therefore, one should be able to distinguish evidence from claims in the first place, rather than integrating both into a demonstration of "what the thing is". For individuals who do not possess such cognition, external support needs to be provided to help them represent claims and evidence independently as the first step to combat confirmation bias in argumentation.

In sum, based on the discussion and reviews above, it can be seen, a cognitive approach to explaining confirmation bias entails a number of mechanisms potentially underlying such bias. First, individuals may be unaware of the confirmation bias induced by associative-type errors as a result of existing beliefs. Thus, the design of cognitive strategies as a remedy to confirmation bias should address such unconscious process of information. Second, individuals may lack an understanding of the distinction between claims and evidence/reasons such that they tend to construct argumentation in a flawed manner. Thus, a cognitive remedy to confirmation bias in argumentation should facilitate such understanding.

Belief Change and Readers' Transaction with Reading Materials

Educational researchers recently have begun to examine belief change on controversial topics for which evidence is available for both sides of the issue. Such research has usually used the term "topic belief". With a few exceptions (e.g. see D'Mello, Lehman, Pekrun, & Graesser, 2014, for an emotion-based account of belief change), most studies on topic belief change have generally examined belief change after reading arguments, conclusions and/or evidence on both sides of a controversial issue

(e.g., climate change, whether transgenetic food is harmful). Two characteristics of research in this area are relevant to the purpose and design of this proposed research. The first is, most studies have focused on text characteristics and their effects on belief change, for instance, targeting how types of text or presentation of text can increase the likelihood of belief change. The second is findings suggesting explicitly prompting students to fairly consider both sides of an issue is ineffective for producing belief change.

As far as text type is concerned, Andiliou, Ramsay, Murphy and Fast (2012), for instance, examined the persuasive effects of intratextual messages on readers' belief change. Intratextual message was defined in their study as a side-by-side combination of two one-sided texts into a single message. The results showed 70% of the readers maintained their initial position on the topic. These participants also demonstrated belief polarization after reading the intratextual message, which contains arguments from both sides of the issue. They suggested the persuasive effect of an intratextual message is minimal and comparable to the effect of a two-sided non-refutational text. Since the intratextual message is inherently complex, it is probable readers either did not sufficiently understand the complicated information presented or processed information from each side in a biased manner to preserve initial beliefs. Along the same line, Diakidoy, Kendeou, and Ioannides (2003) compared the effects of different text structure on belief change in science. They found students reading refutational text achieved more conceptual change gains than students who read expository text, with the effect of the latter comparable to regular instruction. However, the length of the refutational text (1039 words) in their study was about twice the length of the expository text (522 words),

which seems likely to have introduced the amount of information as a confounding variable which could have affected learning gains.

With regard to text presentation, Kobayashi (2010) examined whether the order of pro-argument and anti-argument presentation affects readers' evaluation of these arguments. The results showed presentation order only affected argument evaluation when readers identified the refutational relationship between the pro-arguments and anti-arguments. This suggests readers' awareness of how arguments and counterarguments are related may mediate the effects of text characteristics on belief outcome. Along this same line, Murphy, Long, Holleran, and Esterly (2003) examined whether presentation form of a persuasive message affected belief change. They found whether the message was presented on computer or in paper-based form did not affect belief outcome. In aggregate, research on relationships between text characteristics and belief change seem to have shown limited and sometimes confounded effects of the former. It may be that readers' transactions with text, rather than text characteristics alone, are more critical to belief change outcome resultant from text reading.

So, what do research findings on verbal instructions designed to increase the likelihood of desirable reader-text transactions suggest about belief change? The study conducted by McCrudden and Sparks (2014) is one of a few educational psychology studies published on this topic. They examined the effects of verbal instruction on belief change by comparing four conditions: 1) a rationale instruction plus evidence instruction condition; 2) a rationale instruction only condition; 3) an evidence instruction only condition; and 4) a control condition.

The rationale instruction explicitly emphasized the importance and benefit of considering multiple perspectives on a controversial issue. The evidence instruction explained the nature of evidence and reasons as "types of information that is used to support and justify a position," and prompted individuals to pay close attention to the evidence and reasons on both sides of the issue. It also provided a specific argument example for which the claim and the evidence/reason were respectively identified. Although topic beliefs were lowered after reading in general, pair-wise comparison showed the only significant result was produced by the evidence instruction condition. Such a finding suggests verbal instruction prompting readers to be fair may not be an effective strategy for changing beliefs. In contrast, content that fosters understanding of the role of evidence/reason and facilitates separate representation of claims versus evidence/reason may be a more useful persuasive strategy.

Similarly, there have been research findings in domains of general and social psychology showing that some debiasing strategies are more effective than others. Lord, Lepper, and Preston (1984), for instance, compared two types of bias-correcting strategies' effects on belief change. They found the strategy of making the opposite more salient had a stronger debiasing effect on social judgment than simply describing the targeted bias to participants and asking them to be fair. In the context of formal reasoning tasks, Evans et al. (1994) found verbal instruction on logical rules is not very effective on improving task performance.

Taken together, prior findings seem to suggest explicitly asking belief holders to be objective may not be an effective remedy to confirmation bias. If confirmation bias results from automatic, association-typed processing and/or a lack of understanding of the

distinction between claims and evidence/reasons, it seems doubtful simply asking belief holders to be fair will address the underlying mechanisms of confirmation bias.

Like argumentation and belief change on a controversial topic, conceptual change learning also involves awareness, understanding, and evaluation of belief-inconsistent information, such as anomalous data (Chinn & Brewer, 1993). Thus, cognitive strategies used to facilitate conceptual change learning are likely useful for facilitating unbiased argumentation and reflective belief change. Chinn and Brewer (1993) discussed several factors affecting conceptual change learning outcome and suggested eleven instructional strategies respectively addressing prior knowledge, the alternative theory, anomalous data, and processing strategies. Of these, facilitating deep processing and increasing perceived plausibility of alternative theory seem to be the two strategies most pertinent to the purpose of this proposed research. Deep processing and perceived plausibility of alternatives both can be addressed by using an appropriate cognitive strategy. One strong candidate is elaborative interrogation, a cognitive strategy which has been shown to facilitate deep processing (Pressley, Wood, Woloshyn, Martin, King, & Menke, 1992) and which would seem to have the potential also to increase perceived plausibility of alternatives. In the next section, literature on elaborative interrogation is reviewed in detail to discuss its cognitive mechanism and to analyze its potential as a remedy to confirmation bias affecting quality of argumentation and reflective belief change.

Elaborative Interrogation: Potential Effects on Correcting Biased Processing

Elaborative interrogation is a cognitive strategy originally used to improve learning of factual information by prompting learners to answer “why” questions on the relationship between two things involved in a factual proposition. For example, if the to-

be-learned fact is “The oldest building of any Canadian university is located on the school's main campus,” the corresponding elaborative interrogation question would be “Why do you think the oldest building of any Canadian university is located on the school's main campus?” (Woloshyn, Willoughby, Wood, & Pressley, 1990). To answer the question, learners are encouraged to use their prior knowledge to explicitly build the case whereby the relationship between the state and its characteristic seems plausible. In essence, elaborative interrogation prompts learners to generate information explaining why the to-be-learned fact may be true.

As discussed by Pressley, Woloshyn, Lysynchuk, Martin, Wood, and Willoughby (1990), a learning strategy should entail cognitive processing beyond mental operations learners automatically engage with when processing the material. In this sense, a cognitive strategy intended to improve argumentation and lead to reflective belief change on a controversial topic must achieve several cognitive goals. First, since confirmation bias is caused by association-typed errors, the debiasing strategy must combat the automatic information association (which individuals may not be aware of) preferential to existing beliefs. Second, the strategy should enable learners to use a more sophisticated model of argumentation based on separate representation of claims and evidence or reasons. Third, it should facilitate understanding of belief-inconsistent arguments such that learners can develop effective rebuttals and/or change beliefs accordingly. Following I make the case that elaborative interrogation has the potential to correct confirmation bias in the process of reading belief-inconsistent arguments. I also propose a specific type of elaborative interrogation here to achieve these cognitive goals.

Elaborative interrogation is different from other elaboration strategies (e.g., the strategy of elaborated questions used in Golanics and Nussbaum, 2008) in that it does not provide any additional information beyond what is already contained in the fact itself. Thus, effects of elaborative interrogation on learning can only be attributed to the cognitive processes which elaborative interrogation itself entails, without introduction of confounding effects from the addition of information by the strategy. Studies on elaborative interrogation began at the end of 1980s and developed into a coherent line of research in 1990s. Its positive effect on factual learning has been established based on experimental findings on learners of different age and knowledge level, and on to-be-learned materials of different format. Also, although many researchers had directed attention away from elaborative interrogation studies by the end of the 1990s, in recent years several researchers (e.g., Dornisch & Sperling, 2006, 2008; Dornisch, Sperling, & Zeruth, 2011; Ozgungor & Guthrie, 2004) have extended the scope of elaborative interrogation by examining its effects on higher-order learning. This section reviews studies of effects of elaborative interrogation on factual and higher-order learning, such as inference making and problem solving. The section also discusses these effects in relation to the causes of confirmation bias.

Effects of Elaborative Interrogation on Factual Learning

Early research on elaborative interrogation has documented its effects on improving factual learning, with large effect sizes noted when the learning outcomes were measured by association and/or recognition test items (e.g., Pressley et al., 1992). For example, Wood, Pressley, and Winne (1990) compared learning effects of elaborative interrogation, experimenter-provided elaboration, imagination, and free study (the control

condition) on learning of two types of factual materials. Their Experiment 1 used arbitrary facts in the form of single sentences, with one sentence describing a man with a certain feature engaging in an activity which was random to the feature (e.g., The tall man bought the crackers.). Experiment 2 used more ecologically valid material consisting of animal-related facts in the form of a prose message in which six sentences were combined into a paragraph. Each sentence stated a real characteristic of the animal (e.g., The skunk mostly eats corn.) and learning outcomes were measured by cued-recall items which were of an associative nature (e.g. Which animal mostly eats corn?). In both experiments, Wood et al. found the elaborative interrogation conditions produced significantly better learning outcomes as compared to all other conditions.

Seifert (1993) compared effects of elaborative interrogation on learning a prose passage on animal characteristics to an underline-only condition and an underline with provided elaboration condition. He found participants in the elaborative interrogation condition outperformed other participants on associative memory tests. Likewise, Seifert (1994) compared an elaborative interrogation condition and a condition of answering verbatim-response questions which asked participants to locate and copy the to-be-learned information from the prose message. He found elaborative interrogation participants outperformed verbatim-response participants on matching test items. Moreover, Woloshyn, Willoughby, Wood, and Pressley (1990) found even when elaborative interrogation participants failed to recall complete facts, they still outperformed control participants on tests of the associations between the two things involved in the facts (e.g., a university and a factual attribute of the university, as used in their study). These findings suggest, by inducing association-typed processing,

elaborative interrogation can be an effective cognitive strategy to improve learning of facts.

Effects of elaborative interrogation on factual learning also seem to be long-lasting. Willoughby, Waller, Wood, and MacKinnon (1993), for instance, found the positive effect of elaborative interrogation on factual learning was still present when tested one month after study of the facts. Similarly, Kahl and Woloshyn (1994) found the advantage of elaborative interrogation group relative to reading controls was maintained in both 30- and 60-day follow-ups. Moreover, Woloshyn, Paivio and Pressley (1994) found elaborative interrogation effects to be present for up to 6 months after experimental sessions.

Interestingly, Woloshyn et al. (1990) found even when participants in the elaborative interrogation condition failed to generate adequate answers to the "why" questions, their factual learning was still improved, with these findings later replicated by Woloshyn et al. (1994). These researchers explained these findings by referring to the automatic activation of a semantic memory network related to the to-be-learned facts, which arguably would strengthen memory of the association between two things contained in the facts. They also emphasized such a finding has educational significance because not all students are able to generate adequate answers to elaborative interrogation questions when they are exposed to the material for the first time. It also seems the learning effects of elaborative interrogation are comparable to certain other effective learning strategies. For instance, the learning gains from elaborative interrogation were found to be of comparable size to those produced by visual imagery on learning factual information (e.g., Pressley et al., 1988, as summarized by Menke and Pressley, 1994).

Effects of Elaborative Interrogation on Higher-Order Learning

Effects of elaborative interrogation on factual learning have been replicated under conditions that include variations in group sizes (e.g. Kahl & Woloshyn, 1994), individual versus collaborative learning contexts (e.g., Wood, Fler, & Willoughby, 1992), and use in special populations (e.g., Greene, Symons, & Richards, 1996). Researchers interested in examining the role of elaborative interrogation in higher-order learning (inference making, integration, coherence construction and problem-solving transfer), however, have found data patterns more complicated and mixed than findings on the learning of factual information.

Some studies have shown elaborative interrogation is effective for some types of higher-order learning, but not for others. For instance, McDaniel and Donnelly (1996) designed two text type conditions for each of twelve scientific concepts. One text type was a literal description of the concept and the other was an analogy that related the concept to a domain familiar to their participants. All participants were randomly assigned to the two text type conditions, and to three strategy conditions including elaborative interrogation condition, pictorial schematics condition, and key-word highlighting condition in a 2×3 factorial design. They used multiple-choice items as the outcome measure. Some of these items measured learning at the level of factual recognition, and the remaining measured learning at the inference level (e.g., What would happen if a star expanded instead of collapsing?). McDaniel and Donnelly found elaborative interrogation produced learning gains in both factual and inference learning, and such effects were present regardless of text type conditions.

Further, Ozgungor and Guthrie (2004) examined effects of elaborative interrogation on different types of higher-order learning from reading scientific article. They used short-answer questions and matching tasks to measure recall, along with an inferences verification task (judging whether experimenter-provided inferences are true or false) which measures text-based inference making. The internal consistency of participant-generated semantic networks was assessed for measuring coherence construction as a type of higher-order learning other than inference learning. They found conditions (elaborative interrogation versus reading control) explained differences in outcome from recall and inference making measure, but not performance on the coherence construction measure.

Along the same line, Dornisch and Sperling (2006) compared participants in elaborative interrogation and reading control conditions on factual recognition, free recall, and problem-solving transfer. The text they used was on the topic of principles in retail, merchandising, and accounting, and presented on a computer screen with elaborative interrogation questioned listed along the side of the text. Dornisch and Sperling found elaborative interrogation was most effective for factual recognition, but had only limited effects on free recall, where significant differences were found for immediate recall, but not delayed recall. No significant effects were observed on problem-solving transfer. In addition, Dornisch et al. (2011) used text on the topics of standardized testing and normal distribution and had participants complete matching items, multiple-choice items, open-ended items, factual recall items, integration questions, and a problem-solving transfer item. To answer the integration questions, participants needed to utilize information across sentences or paragraphs. Elaborative interrogation was found to have no

significant effect on integration and problem-solving transfer as compared to other conditions. Thus, in aggregate, these findings suggest as far as higher-order learning is concerned, elaborative interrogation may be an effective strategy for improving inference learning, but may not be useful for improving coherence construction, integration, and problem-solving transfer.

Factors Affecting the Effectiveness of Elaborative Interrogation

In addition to the differentiated effects of elaborative interrogation on different types of higher-order learning reviewed above, text and learner characteristics also seem to matter with regard to the extent to which elaborative interrogation is effective. Specifically, the amount of elaboration contained in the text, topic domain of the text, and level of learners' prior knowledge are variables shown to affect the effectiveness of elaborative interrogation.

As far as text characteristics are concerned, effects of elaborative interrogation seem to be affected by the amount of elaboration contained within the text. For example, Greene et al. (1996) found elaborative interrogation had a considerable effect on recalling single facts but the effects were mixed on recognition and comprehension of paragraph-length materials, depending on whether the paragraphs consisted of sentences which already included some elaborative detail. Specifically, elaborative interrogation only improved recall for paragraphs consisting of sentences not elaborated on.

Topic domain also seems to matter regarding whether elaborative interrogation is effective or not. When Dornisch and Sperling (2008) used text on a statistical topic, elaborative interrogation had no effect on either lower or higher-order learning outcome. In the view of these researchers, this lack of effect was probably due to learners' lack of

prior knowledge needed for generating elaboration at a minimal necessary level. This finding is also consistent with O'Reilly, Symons, and MacLatchy-Gaudet's (1998) results using study material of biological facts. They compared elaborative interrogation conditions with a self-explanation condition and a repetition control condition. Elaborative interrogation participants answered aloud the question "why does it make sense that… (the content of a sentence)?" Self-explanation participants were asked to "…explain what the sentence means to you. That is, what new information does the sentence provide for you? And how does it relate to what you already know?" O'Reilly et al. found no difference between elaborative interrogation and a control condition on cued recall and recognition tests, whereas participants in self-explanation condition performed significantly better than both elaborative interrogation and control conditions. They attributed the absence of elaborative interrogation effects to participants' lack of prior knowledge on the topic of the material.

Along the same line, Woloshyn, Pressley, and Schneider (1992) found although elaborative interrogation improved factual learning for all participants, high-knowledge participants in reading-control condition still outperformed low-knowledge participants in elaborative interrogation condition. Similarly, Woloshyn, Wood, and Willoughby (1994) found use of elaborative interrogation especially benefited participants who had at least some relevant prior knowledge. These findings suggest elaborative interrogation may be useful only when learners are not novices to the topic domain. These findings are consistent with Pressley et al.'s (1992) review that elaborative interrogation generally has a larger effect for adult learners than for children, who presumably have lower knowledge level in the topic domain than do adults.

Research findings reviewed above have important implications in showing the effectiveness of elaborative interrogation as dependent on the level or nature of learning, text characteristics, and learners' prior knowledge in the domain of the to-be-learned information. I now turn to an analysis of cognitive mechanisms which likely explain the entire pattern of elaborative interrogation effects on different levels/types of learning, different materials and learners with different levels of prior knowledge.

The Cognitive Mechanisms of Elaborative Interrogation

This final section provides a review of research findings on elaborative interrogation effects, focusing on comparisons of such effects as a function of learning level/type, text characteristics, and learners' prior knowledge level. Findings from such research have provided empirical basis for an analysis of cognitive mechanisms underlying effects of elaborative interrogation. To examine the potential of elaborative interrogation of being an effective remedy to confirmation bias, cognitive mechanisms of elaborative interrogation should be compared and connected to the cause of confirmation bias affecting argumentation and belief change. Thus, for the purposes of this research, the next section is aimed at answering the following questions. What cognitive mechanisms make elaborative interrogation effective (or ineffective)? Does the presence of such mechanisms indicate elaborative interrogation is likely to be useful for combating confirmation bias? Does elaborative interrogation need to be adapted in order to maximize its potential to improve argumentation and bring about reflective belief change through combating confirmation bias?

Elaborative interrogation as an association-strengthening mechanism. In general, elaborative interrogation researchers agree responding to a "why" question is

likely to strengthen the association between two items and thus primes memory for such associations (Seifert, 1993). Such an association strengthening account of elaborative interrogation effects seems to be plausible, since research evidence suggests elaborative interrogation effects on factual learning is unaffected by the quality of answer generated by individuals in response to the "why" questions (Menke & Pressley, 1994). For example, Menke and Pressley (1994) speculated simply attempting to answer a why question improves memory for facts, and Woloshyn et al. (1994) found the quality of answer in fact had no significant effect on memory. This means, it may not matter whether an answer to the "why" question is based on an analysis of causal relationships between the two items or simply an arbitrary connection of items as created by learners. In other words, elaborative interrogation effects based on an association-strengthening mechanism will be present as long as learners have connected items by any means. Such memory content does not have to be well-justified knowledge on the two items. This means learning of an association could occur regardless of the nature of the association (e.g., causal-logical versus arbitrary) that learners are cognizant of.

The knowledge activation mechanism. In a 1994 study, Kahl and Woloshyn presented empirical data which seemed to provide evidence against the view of association-strengthening mechanism as the sole explanation of elaborative interrogation effects. They observed individuals' memory for facts were better when they generated scientifically correct answers to elaborative interrogation questions by using relevant prior knowledge to clarify target information. In their view, a prior knowledge activation account better explained their findings that students learned more when they were explicitly prompted to activate relevant prior knowledge.

Since quality of answer to elaborative interrogation questions is likely an indicator of learners' prior knowledge, elaborative interrogation studies have grouped answers of differing qualities into categories to examine the role of prior knowledge in learning effects of elaborative interrogation, most typically into three broad categories: adequate answer, inadequate answer, and no-response. In general, an adequate answer explains why the to-be-learned fact may be true. In contrast, an inadequate answer offers no explanation and may constitute a mere repetition of the fact. Importantly, in order to examine the mediating role of quality of answer, Willoughby, Waller, Wood, and MacKinnon (1993) further categorized adequate answers into three subcategories: adequate-correct (explanations which demonstrate expert knowledge), adequate-pat (explanations which are correct but too general), and adequate-incorrect (explanations which are incorrect in spite of an attempt to explain). They found, within the three subcategories of adequate elaborations, the adequate-correct elaborations were associated with greater probability of correct recall than were correct but too general and incorrect elaborations.

In aggregate, these findings suggest prior knowledge, as indicated by quality of answer to the "why" questions, may have a mediating role in the mechanism which makes elaborative interrogation effective for factual learning. However, it seems the mediating role of prior knowledge should be examined on the basis of a more careful distinction among elaboration answers of varied quality and type. Willoughby et al.'s (1993) finding suggests adequate answers to elaborative interrogation questions (i.e., answers which constitute explanations, rather than mere repetition of facts) may not be a homogeneous grouping. It is possible, even likely, whether adequate answers are correct

and specific, correct but too general, or incorrect reflects how much topic knowledge learners possess and/or how much of such knowledge is activated, which in turn mediates the relationship between elaborative interrogation and learning outcomes.

The confirmatory mechanism. In elaborative interrogation studies using random-assignment experimental design, participants in elaborative interrogation condition, on average, have prior knowledge level equal to those in other condition(s) because of random assignment. This to say, for groups of individuals with equal average prior knowledge, those in the elaborative interrogation condition still demonstrated learning gains. Thus, there may be other mechanisms underlying the effectiveness of elaborative interrogation which lead to learning gains in addition to the learning gains attributed to prior knowledge. A confirmatory mechanism may provide explanation to learning gains not explained by the prior knowledge account.

Martin and Pressley (1991) compared elaborative interrogation effects across experimental groups using elaborative interrogation questions of different natures. Some elaborative interrogation participants were asked to explain why the to-be-learned facts make sense, as is conventionally done in elaborative interrogation studies. In contrast, other elaborative interrogation participants were asked to explain why the to-be-learned facts do not make sense. The latter approach was also elaborative interrogation by definition but may have activated a different subset of prior knowledge from that activated by the conventional elaborative interrogation questions. Consistent with their hypothesis, Martin and Pressley (1991) found elaborative interrogation effects were the largest when participants answered questions in a way that confirms the facts, although

answering refuting elaborative interrogation questions also improved learning as compared to reading-control performance.

Based on this finding, it may be inferred there are possibly two cognitive processes underlying elaborative interrogation effect. First, elaborative interrogation strengthens the association between two items by prompting learners to think about their relationship, which is aligned with the previously discussed association strengthening mechanism. Second, elaborative interrogation directs memory search toward the memory content in support of the relationship as stated in to-be-learned facts, which facilitates assimilation of the new information into individuals' existing structure of memory content. The latter process could be accounted for by a confirmatory mechanism. This means some learning gains provided by elaborative interrogation can be attributed to the process of activating memory content which confirms what is stated in the to-be-learned information (Pressley, Wood, Woloshyn, Martin, King, & Menke, 1992).

Furthermore, elaborative interrogation effects attributed to the association strengthening process and the confirmatory process are possibly additive. Since refuting or disconfirming elaborative interrogations can also prompt individuals to think about the relationship between the two items in a fact statement, it is possible the association between the two items is strengthened by refuting or disconfirming elaborative interrogations as well. However, the disconfirming elaborative interrogation does not provide any learning gains by confirming the to-be-learned fact, which possibly explains why Martin and Pressley (1991) found the refuting or disconfirming elaborative interrogation group outperformed the reading control, and the conventional or confirming

elaborative interrogation group outperformed the refuting or disconfirming elaborative interrogation group.

Along this same line, Woloshyn et al. (1994) also investigated whether elaborative interrogation could improve learning of factual information inconsistent with students' existing beliefs, based on the hypothesis students often possessed memory content which could be used to support information inconsistent with existing beliefs. They found although participants across all conditions tended to remember more belief-consistent facts than belief-inconsistent facts, elaborative interrogation did have positive effects on the retention of belief-inconsistent facts. This is a finding particularly important to the current study, which includes conditions involving reading belief-inconsistent arguments on a controversial topic. In general, it could be argued for controversial topics individuals presumably possess relevant memory content that makes elaboration possible. Further, individuals may possess both memory content consistent and that inconsistent with their positions on the topic, which could make the use of elaborative interrogation productive on facilitating learning of belief-inconsistent arguments.

Connections between Elaborative Interrogation and Confirmation Bias

As previously reviewed, Arkes (1991) distinguished among three types of errors as causes of judgment and decision biases, and attributed confirmation bias to the type of association-based errors. He further argued , in order to combat confirmation bias, individuals should be instructed on the use of a strategy which will create new association or change the original ones. Given that it improves association-typed learning, elaborative interrogation seems intuitively to be an appropriate strategy to address

confirmation bias. That is, elaborative interrogation may actually create or strengthen associations favoring learning belief-inconsistent information. Such effects could then neutralize the bias-inducing effects of original associations which typically undermine the learning of belief-inconsistent information.

Specifically, as can be inferred from the feature of the knowledge activation and confirmatory mechanisms discussed above, elaborative interrogation can potentially facilitate encoding of belief-inconsistent content by two processes. First, using an elaborative interrogation strategy may activate individuals' memory content which is in favor of the belief-inconsistent information, which may facilitate the connection between the belief-inconsistent information and individuals' existing knowledge structures. Second, explaining or attempting to explain why belief-inconsistent information makes sense may confirm the association constituted within the belief-inconsistent information, which may facilitate comprehension of the coherence of such information. Thus, elaborative interrogation strategy would seem to hold the potential for strengthening associations tied to belief-inconsistent information for a more balanced encoding of information from both sides of a controversial topic. The resultant balanced encoding may remedy confirmation bias induced by preexisting beliefs on the controversial topic. Therefore, it can be argued elaborative interrogation would be a useful debiasing strategy if utilized to facilitate deep and unbiased processing of belief-inconsistent arguments.

In their disconfirmation model, Edwards and Smith (1996) attribute confirmation bias both to biased evaluation of belief-inconsistent information and biased memory search in favor of preservation of existing beliefs. According to this model, as far as argument learning is concerned, biased memory search results in more refutational

thoughts generated in response to belief-inconsistent content. Also, as Kardash and Howell (2000) have discussed, people with confirmation bias tend to distort belief-inconsistent information to preserve existing beliefs and attitudes, while tending to accept belief-consistent information at its face value. Thus, using elaborative interrogation to combat such asymmetry of information encoding and retrieval on controversial topics entails helping belief-holders take the perspective of an arguer refuting their preexisting beliefs in order to sufficiently process belief-inconsistent arguments in a more objective manner. In other words, elaborative interrogation questions in this case should tend to engage individuals in thinking about why arguments opposing to their beliefs make sense.

Such a suggestion is also congruent with Greenhoot, Semb, Colombo, and Schreiber's (2004) findings from their study of the effects of reasoning context on causal reasoning performance. Their tasks contained information of causal effects inconsistent with participants' prior beliefs. They compared participants' reasoning performance in abstract and personal settings, finding a higher percentage of participants drew accurate conclusions about belief-inconsistent causal effects in an abstract setting than in one that entailed personal perspective. Thus, it seems asking individuals to answer "why it makes sense…" elaborative interrogation questions on the side of arguments which refute prior beliefs may eliminate belief-induced bias by having individuals take a reasoning stance not in favor of their own beliefs.

Similarly, Greenhoot et al. (2004) also found in abstract reasoning settings understanding of information on evidence and experiment control related to the causal scenario positively affected accuracy of reasoning conclusion. In contrast, in personal reasoning settings they found it was accuracy of prior beliefs that was associated with

accuracy outcome. Explaining their results within the framework of dual-process theory, they argued cognitive processes generated by elaborative interrogation could allow learners to tap into both of the two processing routes of dual-process theory to remedy confirmation bias.

Further Connections based on a Dual-Process Account

Petty and Cacioppo (1986) proposed a dual-process model, which distinguished between two routes of processing—central route processing and peripheral route processing. With regard to the processing of arguments, as Murphy (2007) discussed, individuals who evaluate the arguments based on logic and reasons engage in central processing, in which they are usually conscious about their central-processing-based thinking and reasoning. In contrast, individuals whose reasoning is emotionally charged and who rely on heuristics such as the character of the arguer, perceptual prominence of an argument's wording of the argument, or environmental cues to draw conclusions and tend to engage in peripheral processing. They also are unaware of their peripheral-processing-based reasoning.

Confirmation bias could result from processing at central level, peripheral level, or both. Specifically, the research on explanation availability (e.g., Arkes, 1991; Slusher & Anderson, 1996) and the research on simulation heuristics (e.g., Galinsky & Moskowitz, 2000; Hirt, Kardes, & Markman, 2004) specifically may provide a central processing and a peripheral account of confirmation bias. As the two levels of processing often occur simultaneously, elaborative interrogation strategy could address cognitive mechanism of confirmation bias at both levels. Thus, it may be useful to examine the roles of explanation availability as a type of central processing and simulation heuristics

as a type of peripheral processing to shed light on mechanism connections between elaborative interrogation and confirmation bias.

Explanation availability as central processing. Explanation availability refers to whether an explanation of a belief is readily available for memory search. Theoretical discussion and empirical evidence seem to converge on the effects of explanation availability as a critical factor contributing to both confirmation bias and belief change. Nickerson (1998) has argued confirmation bias results from the causal reciprocity between the stance a person takes and the availability of reasons supporting that stance. In other words, people take a stance because they can think of many reasons to support it (or no reason not to support it), and in turn, the endorsed position can facilitate retrieval of supporting reasons and thus make such reasons increasingly available. He also argued people fail to consider alternatives to a hypothesis because plausible alternatives and arguments supporting these alternatives do not spontaneously come to mind. Such discussion is consistent with studies on topic belief change previously reviewed. For example, Murphy and Alexander (2004) argued strong arguments which foster belief change are usually causal or explanatory in nature, which presumably makes the alternative belief plausible. Therefore, a remedy to confirmation bias in argumentation may debias in two ways—one by making belief-inconsistent arguments more available and the other by cognitively engaging individuals in a way that makes the plausibility of belief-inconsistent argument more prominent to them.

Slusher and Anderson (1996) examined the effects of the availability of causal explanation on belief change on scientific topics. They hypothesized providing causal arguments may directly shift the balance of available explanations in favor of the right

belief and thus lead to desirable belief change. They also posited causal arguments are less likely to be discounted, as what biased belief holders usually do when evaluating refuting arguments. Their results showed causal arguments produced the greatest belief change, and the availability of such arguments mediated this effect. In addition, they also found causal arguments were less subject to biased evaluation. These effects were present three weeks after the experiment session. Relevant to the proposed research, it is worth noting Slusher and Anderson explicitly connected their research to elaborative interrogation, suggesting elaborative interrogation could be used to facilitate learning of belief-inconsistent content by prompting the generation of causal explanation of belief-inconsistent content. In other words, self-constructed causal explanation in response to elaborative interrogation questions can make explanations of belief-inconsistent content more available and less likely to be discounted.

Similarly, Arkes (1991) reviewed findings on explanation bias—the tendency to believe an event is more likely to happen after providing causal explanations on why the occurrence of such event is plausible. Explanation bias is present even when individuals are well aware the event they explain is completely hypothetical. For example, Anderson and Sechler (1986) found explaining why two variables might be related produced an increased belief in the explanatory account generated for the hypothetical relationship and an increased use of such account. They also found such explanation bias was remediable by debiasing effects produced by a counter-explanation task. Further, they found beliefs induced by self-generated explanation did not lead to biased evaluation of new data and presentation of new data showing no relation between the variables moderated the explanation-induced beliefs.

As a potential effect of explanation bias, answering or attempting to answer "why" questions about belief-inconsistent arguments could possibly change the imbalance between high explanation availability on the side of a controversial topic an individual takes versus low explanation availability on the side the individual objects to. It also could help belief holders understand the plausibility of belief-inconsistent arguments by prompting them to generate a causal account of their plausibility. As a result, argumentation can likely be improved to be less belief-biased and contains more sophisticated coordination of arguments and counterargument based on thorough understanding of the latter. Also, the improved argumentation may lead to belief change or belief retention on a better justified basis.

Simulation heuristics as peripheral processing. Confirmation bias has been shown to be partially attributable to automatic processing primed by heuristics from memory content, which are made available and prominent by existing beliefs (Kunda, 1990). An instance of such heuristic cues has been reviewed by Arkes (1991). That is, after individuals imagine experiencing an event, they tend to rate the event as more likely to occur than do individuals who do not imagine it. The imagination of experiencing an event alone does not constitute any evidence on the likelihood of the event. However, imagination may have provided a mental simulation of the event. At the peripheral processing level, such simulation may serve as a heuristic that cues the likelihood of the event and thus increases a belief on the likelihood.

Heuristics also can be externally produced in favor of belief-inconsistent content to attenuate the biasing effect of belief-consistent heuristics. Galinsky and Moskowitz (2000), for instance, examined the impact of exposure to counterfactual scenarios on

subsequent behavior and judgment. They found exposure to counterfactual scenarios can bias or debias thought and action by increasing the accessibility of relevant alternatives. Further, they discussed such scenarios can prime a mental simulation mind-set which can be transferred to other problem solving or social judgment contexts. Along this line, Hirt, Kardes, and Markman (2004) tested whether having participants generate alternatives can produce a mental simulation mind-set which debiases judgments in unrelated domain. They found when participants perceived alternative generation tasks as easy to perform, the debiasing effect of such tasks was transferable both across task contexts within the same domain and across different domains.

It could be argued when individuals are asked to answer elaborative interrogation questions to justify the belief-inconsistent arguments, they may need to activate a scenario portraying the hypothetical truthfulness of the arguments in the first place in order to explain why the arguments may make sense. Such a scenario could serve as a mental simulation which provides heuristics for subsequent peripheral processing underlying argumentation and belief change or retention. Congruent with this speculation, Wood et al. (1992) found participants in the elaborative interrogation condition consistently used more imagery strategies than did the control participants, suggesting elaborative interrogation may induce some kind of mental simulation as speculated above. Perhaps more importantly, the mental simulation heuristic may neutralize the belief-based confirmation bias against belief-inconsistent arguments. It is also possible such mental simulation primes memory search in favor of belief-inconsistent content and thus corrects biased memory search preferential to prior beliefs. As a result, memory content accessed during argumentation and belief change/retention would become more balanced

on both sides of the controversial issue because of increased accessibility of belief-inconsistent content.

An Adapted Version of Elaborative Interrogation

Although elaborative interrogation has been studied in relation to learning of both single facts and prose messages, it relies in its essence on an explanation of the association between two items and seems most readily applicable for learning information that having a relatively simple structure. As will be recalled, the basic structure of an argument consists of two components: a claim and evidence/reason. Thus, elaborative interrogation questions on the argument could be worded as "Why do you think the evidence/reasons support the claim?" Even in their simplest form, however, arguments contain more information than sentences stating a fact. Thus, to avoid cognitive overload, an elaborative interrogation question on an argument should not repeat the content of the claim and the evidence/reason in the same way an elaborative interrogation question on a single fact repeats the two items and their association as stated in the to-be-learned fact. Thus, when elaborative interrogation is utilized to help individuals understand and explain an argument, individuals may need additional cognitive support to represent the structure of the argument as well as content of the claim and evidence or reasons. Thus, an elaborative interrogation strategy was adapted for the current proposed research.

Shaw (1996) argued three criteria can be applied to evaluate informal arguments. The first is an evaluation of whether the premises and conclusions are true, while the second is an evaluation of the relationship between the premises and conclusions to determine whether the argument is valid. The third criterion is a higher-order evaluation,

namely an assessment of how well the argument addresses relevant information on both sides of the topic. Shaw argued the first two criteria must be based on separate representation of premises versus conclusions. She also reasoned improving representations of relationships between premises and conclusions may help people generate more valid arguments and counterarguments.

Shaw (1996) also presented experimental evidence suggesting (1) participants did not make the distinction between claim and evidence spontaneously; and (2) having participants identify premises and conclusions had the effect of improving their performance on formulating rebuttals to the arguments. Therefore, in the current research, an elaborative interrogation strategy was adapted by incorporating a prompt related to identification of claims as well as one for identifying evidence/reasons. Chapter 3 provides more detail on the adapted elaborative interrogation strategy and how it was administered in the actual experiment.

Adapting elaborative interrogation strategies may also increase the likelihood of belief change by mitigating the difficulty individuals might experience when processing belief-inconsistent arguments. To account for the mixed evidence on effects of the strategy "consider-the-opposite" to remedy belief-induced bias, Schwarz et al. (2007) conducted an illuminating study on how individuals' subjective experiences on an alternative-generation task—which prompts individuals to list alternatives to their existing beliefs on a topic—mediated the debiasing effects of such tasks. As shown by Schwarz et al.'s findings, if participants had difficulty coming up with alternatives (e.g., when they are asked to list twelve alternatives), their prior beliefs tended to become even stronger after working on the task. In contrast, participants tended to change their beliefs

when they perceived generation of alternatives as easy after working on the task (e.g., when they are asked to list only three alternatives). Such findings also are consistent with those of Hirt et al. (2004), who found ease or difficulty of subjective experiences in generating alternatives affected belief change outcome.

Schwarz et al. (2007) also conceptualized a specific type of metacognitive experiences termed "processing fluency", which they argued are applicable to situations where individuals are exposed to belief-inconsistent content. According to this perspective, processing fluency is high when individuals perceive belief-inconsistent information as easy to process and low when they perceive such information as difficult to understand. In the case of argument processing, processing fluency refers to the ease of representing and connecting information contained in an argument. Incorporating a prompt on the identification of claims versus evidence/reasons of belief-inconsistent arguments may increase the processing fluency individuals experience when trying to understand these arguments. Thus, the adapted elaborative interrogation may produce greater likelihood of individuals' reflective belief change after reading belief-inconsistent arguments than merely having them respond to "why" questions on the arguments.

In sum, the adapted elaborative interrogation in the present study consisted of two types of questions. Questions of the first type constituted a prompt for separately identifying the claim and evidence/reasons contain in a belief-inconsistent argument. Questions of the second type constituted a prompt for explaining the relationship between the claim and its evidence/reasons. Based on previous discussion, adapted elaborative interrogation can likely optimize individuals' transactions with belief-inconsistent arguments. Thus, improved quality of argumentation and reflective belief change is

expected to be observed after reading belief-inconsistent arguments and responding to adapted elaborative interrogation questions.

This section of the current chapter has provided a review of the literature on elaborative interrogation effects on factual and other types of learning. It also has outlined likely cognitive mechanisms underlying elaborative interrogation, and connected these mechanisms to cognitive causes of confirmation bias. Based on the reviews and discussions, an argument is presented elaborative interrogation has the potential to remedy confirmation bias and improve quality of argumentation after individuals have been exposed to belief-inconsistent arguments. In addition, an adapted version of elaborative interrogation is judged likely to facilitate processing basic structure of arguments and thereby increase the likelihood of argumentation improvement and reflective belief change.

However, belief-holders' own capabilities and inclinations as knowledge builders may also need to be considered. For instance, individuals' motivation to engage in deep processing of content they disagree with may affect (1) how well they understand belief-inconsistent arguments and construct rebuttal to them; and (2) how well they react to the adapted elaborative interrogation. This so-called need for cognition is a cognitive motivation construct which has been shown to have a significant relationship to how individuals process information and thus seems likely to affect quality of argumentation as well as the effectiveness of elaborative interrogation. The next section reviews literature on need for cognition and discusses how it can affect argumentation and might interact with elaborative interrogation.

Need for Cognition

Need for cognition was conceptualized by Cacioppo and Petty (1982) as a personality trait which reflects individuals' motivation to engage in effortful thinking. Extant literature on need for cognition has provided evidence on its relationship to both cognitive processes and outcomes, such as level of information processing (e.g., McAuliff & Kovera, 2008; Stayman & Kardes, 1992), argumentation (e.g., Cacioppo, Petty, Feinstein, & Jarvis, 1996; Nussbaum & Bendixen, 2003), and belief change (e.g., Bradley III & Meeds, 2004; Gibbons, Busch, & Bradac, 1991). Studies like these have shown individuals with high need for cognition tend to be more motivated to argue for their position, better able to objectively evaluate the quality of argumentation, and less likely to demonstrate belief polarization when instructed to reflect on their beliefs.

Effects of Need for Cognition on Learning Process and Outcome

Since need for cognition reflects individuals' tendency to enjoy intellectually challenging activities, individuals with high need for cognition generally will be highly motivated to engage in deep information processing and higher-order learning. Research evidence has shown individuals with high need for cognition are more interested than low need for cognition individuals in complex and challenging information (e.g., Worthington, 2008). As a result, these individuals are more likely to demonstrate desirable learning processes and belief outcomes than do individuals with low need for cognition. For example, Kuo, Horng, Lin, and Lee (2012) found high need for cognition was associated with better recall. As far as higher-order learning is concerned, Stayman and Kardes (1992) found individuals with high need for cognition also tended to engage more in inference making. In addition, Mahoney and Kaufman (1997) found participants with

high need for cognition had significantly fewer irrational beliefs than participants with low scores.

Perhaps most importantly for the current study, high need for cognition also seems to be associated with processing of true merit of the to-be-learned information, whereas low need for cognition is associated with processing of surface heuristics of information being considered. For instance, Vidrine, Simmons, and Brandon (2007) found participants with high need for cognition were more likely to process the fact-based message, whereas individuals with low need for cognition were more likely to react to the emotion-based message. Likewise, Nettelhorst and Youmans (2012) found participants with low need for cognition were more likely to change their attitude when exposed to surface features of a product, whereas participants with high need for cognition were more likely to change their attitude when exposed to substantive features.

Need for Cognition and Argumentation

Because high need for cognition is associated with higher level of information processing, it is more likely individuals with high need for cognition will examine arguments and beliefs on a more objective basis. Research findings have suggested individuals with high need for cognition do in fact tend to examine arguments more carefully and are more likely to detect flaws in arguments. McAuliff and Kovera (2008), for instance, found jurors with higher need for cognition were more likely to notice the methodological flaws contained in expert evidence then were jurors with low need for cognition. Moreover, it also seems individuals with high need for cognition tend to form their beliefs more carefully and are more likely to accurately evaluate the nature of available evidence. For example, Kardash and Scholes (1996) found conclusions

generated by individuals with high need for cognition were more likely to be accurate about the tentative nature of the mixed evidence to which they were exposed.

As need for cognition is by nature a cognitive motivation construct, individuals with high need for cognition may be more motivated to argue for their stances on controversial topics. For example, Nussbaum and Bendixen (2003) found participants with high need for cognition tended to engage in social arguments or debates. Further, given that need for cognition has been empirically shown to be associated with deep processing, it is also possible individuals with high need for cognition have the habit in their daily lives of thinking deeply about controversial topics, as well as thoroughly examining information relevant to such topics. Thus, individuals with high need for cognition may be both more motivated and better able to elaborate on their positions on controversial topics, as compared to individuals with low need for cognition.

Need for Cognition and Effects of Elaborative Interrogation

As previously described, need for cognition has been shown to relate to learning in general, as well as to the processes and outcomes of argumentation in particular. Thus, it is possible individuals with high versus low need for cognition also will react differently to use of an elaborative interrogation strategy, a strategy designed to facilitate deep and unbiased information processing in this propose research.

Elaborative interrogation likely affects learning based on several mechanisms previously discussed. For instance, whether elaborative interrogation can lead to learning gains depends in part on how much prior knowledge learners possess on the to-be-learned topic. The more topic knowledge learners possess, the more knowledge will be likely activated by use of elaborative interrogation, which then contributes to learning. Because

of a general tendency to attend to topic relevant information, individuals with high need for cognition may possess more topic knowledge to be activated by use of elaborative interrogation. In addition, individuals with high need for cognition may search their prior knowledge more thoroughly than those with low need for cognition when answering elaborative interrogation questions. As a result, individuals with high need for cognition may be more likely to benefit from use of elaborative interrogation. As far as argumentation is concerned, individuals with high need for cognition may both have more topic knowledge to be activated by use of elaborative interrogation and be more motivated to search their prior knowledge to respond to the elaborative interrogation questions. As a result, individuals with high need for cognition may demonstrate greater gains in quality of argumentation after using elaborative interrogation to process belief-inconsistent arguments, as compared to individuals with low need for cognition.

On the other hand, however, it could be argued individuals with high need for cognition will process the belief-inconsistent arguments no matter whether they use the strategy of elaborative interrogation or not. Thus, using elaborative interrogation likely will not contribute much to the improvement of argumentation for individuals with high need for cognition. In this sense, individuals with low need for cognition may be more likely to benefit from use of elaborative interrogation.

In sum, based on prior research, it seems very likely need for cognition will be positively related to quality of argumentation. It is also likely, however, an interaction between need for cognition and the use of elaborative interrogation seems likely in their effects on the quality of argumentation after reading belief-inconsistent arguments. At the same time, however, it is unclear what specific direction such interaction will take. That

is, it is possible participants with high need for cognition would benefit more from using elaborative interrogation as compared to those with low need for cognition, but the opposite is also possible. The third research question posed at the end of Chapter 1 thus focused on (1) examining the relationship between need for cognition and quality of argumentation, and (2) exploring a possible interaction between need for cognition and elaborative interrogation on affecting argumentation.

The Need for Cognition Scale (NFC), developed and refined by Cacioppo and colleagues (Cacioppo & Petty, 1982; Cacioppo, Petty, & Kao, 1984), is used to measure individuals' level of need for cognition. The NFC is designed to measure how much individuals enjoys intellectually challenging situations and whether they are motivated to engage in effortful cognitive activities on a five-point Likert-type scale shown to have a single-factor structure (e.g., Cacioppo, Petty, & Kao, 1984). An example item is: "I would prefer complex to simple problems." Higher agreement with this item indicates higher need for cognition. Another example item is: "Learning new ways to think doesn't excite me very much." Higher agreement with this item indicates lower need for cognition.

At this point, relevant studies on argumentation, belief change, confirmation bias, elaborative interrogation, and need for cognition have been examined. To answer the three research questions on relationships among these variables as posed at the end of Chapter 1, several key questions on methods of this research were addressed first in two pilot studies. These questions included the following. What reading materials are most appropriate for addressing this study's research questions? Similarly, what measures of the dependent variables—quality of argumentation and topic beliefs—are likely to be most appropriate for examining effects of elaborative interrogation and need for

cognition on these dependent variables? Furthermore, what research procedures are most likely to provide the most trustworthy evidence about the effects of elaborative interrogation on argumentation and topic beliefs? In the next section, brief description of the methods and results from two pilot studies and their relationship to relevant prior research are presented and discussed.

Pilot Studies

This section reviews two pilot studies conducted to refine the focus and methodology of the primary study of this dissertation research. The following two subsections summarize methodological question(s) addressed by the pilot studies, methods of each pilot study, and relevant findings from each. Based on the implementation and results of these studies, decisions about methods to be used in the main study were made.

Pilot Study 1

Pilot Study 1 questions. The reading materials used in this research was based on a controversial topic in a social domain. The rationale for using controversial topics in a social domain involves the complexity and bias-conducive nature of reasoning in such domains. Argumentation in a social domain is usually complicated and both children and adults reason more poorly in a social domain (Kuhn, Garcia-Mila, Zohar, & Andersen, 1995). Since some social topics are more controversial than others, it was important to make sure materials used in the current study were based on a truly controversial social topic and functioned well in the experimental context. Thus, Pilot Study 1 was conducted to test whether reading materials based on an initially considered topic would actually be controversial from the standpoint of the likely college-age participants.

Methods. The topic initially considered for this study came from an article and comments on the article published in The New York Times on whether algebra should be required for students at the level of secondary education (Hacker, 2012). The original article and comments on it were edited by the present researcher into six arguments favoring mandated algebra and six arguments against mandated algebra. All arguments were of approximately equal length. All arguments were structured in the same way, with a claim followed by a reason or evidence supporting the claim. These arguments were presented via an online survey to a group of 26 students from an undergraduate educational psychology class in a large Midwestern university. These participants were provided with a link to an online survey containing all of the twelve arguments. After reading each argument, participants were asked to rate how persuasive the argument was on a five-point Likert-type scale item. After reading all arguments, participants were prompted to reflect on the arguments and report their own stance on the topic by indicating whether they thought algebra should continue to be required at the secondary education level or not.

Results. Results from Pilot Study 1 showed: (1) only 2 of the twenty-six 26 participants took the position against mandated algebra at secondary education; and (2) participants judged the arguments favoring mandated algebra at secondary education to be significantly more persuasive than the arguments on the opposite side. These results thus clearly showed the algebra topic, as viewed by undergraduate participants, was not sufficiently controversial for the purpose of this research.

Decisions about conducting the current research. Based on results of Pilot Study 1, materials on the topic of whether or not algebra should be required at secondary

level were eliminated from further study. A second set of materials was then considered, which was based on the topic of whether the state should adopt the Common Core State Standards for Mathematics (National Governors Association Center for Best Practices & Council of Chief State School Officers, 2010). Common Core State Standards for Mathematics (referred to as CCSS-M below) are designed based on excellent state standard by experienced teachers, content experts, and state governors and leaders, for a purpose to address the problem of curriculum which covers a wide range of topics in a shallow manner. CCSS-M clearly specifies what a student should know and be able to do in mathematics at the end of each grade, which is K-8, and at the end of high school (grades 9-12). CCSS-M was launched in 2010 () and is currently adopted by 42 states of the United States and not adopted by the remaining 8 states (Common Core State Standards Initiatives, 2016; Standards in Your State, 2016).

At both the state and national level, however, there has been considerable disagreement over whether CCSS-M will, if implemented, be effective in improving mathematics learning. Thus, the topic of whether the state should adopt CCSS-M was judged to be more controversial than the algebra topic tested in Pilot Study 1. Whether the CCSS-M topic was actually controversial from the standpoint of college-age participants was tested in Pilot Study 2, along with several design, measurement, and procedural features used in the current research.

Pilot Study 2

Pilot study 2 questions. The purpose of Pilot Study 2 was to test whether the overall design, reading materials and measures could effectively address the research questions previously posed. Specially, Pilot Study 2 was designed to inform decisions

about four design-related questions. (1) are reading materials based on the CCSS-M Topic sufficiently controversial and appropriate for the research purpose of examining effects of elaborative interrogation on argumentation and belief change? (2) what kind of scoring rubric is sufficiently reliable and appropriate to measure quality of argumentation as an outcome likely affected by using elaborative interrogation to process belief-inconsistent arguments? (3) is the methodological approach of exposing participants to only belief-inconsistent arguments an effective way to maximize the likelihood of argumentation improvement and belief change? and (4) is a measure of topic beliefs developed by the present researcher sufficiently reliable and valid? The rationale for the design of materials, measures, and procedures is discussed below, followed by a review of the methods and relevant results of Pilot Study 2.

Using simple-structure arguments on the CCSS-M topic. As previously discussed, the CCSS-M topic was judged by the researcher to be controversial from the standpoint of the college-age participants who would participate in the planned study, and each argument should be constructed in ways reflecting the basic structure of argument, consisting of a claim followed by evidence/reasons in support of the claim. Choice of such material design was based on two reasons. First, reading a group of short, mutually independent arguments was judged to be likely to reduce extraneous cognitive load which would be generated by having to identify each argument from a complicated prose message which integrates multiple arguments. Second, elaborative interrogation is a strategy most often applied to process the association between two items (see a review by Pressley et al., 1992), suggesting the argument structure simplified into a claim plus

evidence/reason format may be most appropriate for testing the effectiveness of elaborative interrogation.

Judging potential argumentation scoring rubrics. The literature on argumentation research has provided a variety of ways to assess quality of argumentation. However, most scoring rubrics from prior studies can be grouped into two types based on whether the assessment scoring is based on (1) a continuous scale or (2) number of dichotomous checks. Studies using scoring rubrics of the first type evaluated quality of different aspects of argumentation on a continuous scale. For example, Hand and Choi (2010) assessed argumentation on a ten-point scale in terms of how well claims and evidence are connected and how coherent the flow of an argument is. Likewise, Tawfik and Jonassen (2013) assessed argumentation on a five-point scale based on the degree of consistency among claim, counter claim, and rebuttal, and the degree of specificity of the explanation or elaboration on the claim, while Braten, Ferguson, Strømsø, and Anmarkrud (2014) assessed argumentation on a seven-point scale based on how well opposing perspectives are discussed and elaborated, and how consistent and relevant an argument is.

There are only a few studies which have used the second type of scoring rubric, which applies a sequence of dichotomous check to assign a final score to an argumentation (e.g., Sampton & Clark, 2008, 2009). For instance, Sampton and Clark (2009) adopted a scoring rubric based on a number of dichotomous checks on a hierarchy of argumentation features. In their approach, for instance, a "yes or no" question is asked from the top of the hierarchy (e.g., "Does the explanation have any facet scored as inaccurate?") and moving toward the bottom of the hierarchy (e.g., "Does the explanation

have any facets scored as incomplete?"). The final score of quality of argumentation was dependent on the number of "yes" responses to all dichotomous checks. Since responding to the "yes or no" question is more clear-cut than grading quality of argumentation on a continuous scale, the dichotomous check rubric was expected to be more objective than the continuous scale-based rubrics. To evaluate which type of argumentation scoring rubric would be most reliable and appropriate for the purpose of this research, two rubrics were developed. One rubric was developed based on continuous scale and the other based on dichotomous checks. Pilot Study 2 tested both rubrics to determine which one was likely more reliable and appropriate for this research.

Exposure to belief-inconsistent arguments only. Although most prior studies on topic-belief change on controversial topics have exposed participants to information from both sides of an issue, results from these studies have generally shown minimal belief change after reading (e.g. Andiliou et al., 2012; Kunda, 1990; McCrudden & Sparks, 2014). Beliefs-based confirmation bias on a controversial topic may be in part attributed to selective attention to information in favor of one's own topic position. Thus, exposing participants only to belief-inconsistent arguments could be expected to exclusively focus their attention on the belief-inconsistent information without interference from the attention-grabbing belief-consistent arguments. Moreover, since confirmation bias is induced when belief-consistent content is more available and accessible than belief-inconsistent content (Tversky & Kahneman, 1973), exposing participants only to belief-inconsistent arguments could increase the availability and accessibility of belief-inconsistent arguments, and therefore favor their unbiased processing. Thus, a design which exposed individuals only to belief-inconsistent arguments was judged to make

optimal processing of these arguments more likely in the context of using elaborative interrogation. Pilot Study 2 tested the power of the above design for detecting the likely effects of elaborative interrogation on quality of argumentation and belief change.

Validation of a measure of topic beliefs. A six-point Likert-type scale consisting of twelve items was developed by the researcher for individuals to report their beliefs on the CCSS-M topic. The stem of each item was the first sentence (claim) of each argument about whether the state should adopt CCSS-M. Six items were designed to measure how much participants agree the state should adopt CCSS-M. The other six items were designed to measure how much one agreed with the position that the state should not adopt CCSS-M. The scale thus theoretically would be expected to contain a pro-CCSS-M factor and an anti-CCSS-M factor, and Pilot Study 2 tested the internal consistency reliability and construct validity of this scale.

Methods. One hundred and eight (108) students from four undergraduate educational psychology classes participated in Pilot Study 2. These students were drawn from the same population as those who would likely participate in the proposed research. Reading materials of Pilot Study 2 included six arguments in favor of adopting the CCSS-M, and six arguments against adopting it. All arguments were structured in the same manner, with a claim followed by a reason or evidence supporting the claim. Participants were first introduced to the CCSS-M topic generally and then prompted to rate their own position for or against CCSS-M, by using the 12-item, six-point Likert-type scale previously described. Then they were asked to construct argumentation to justify their position on the topic.

Next, participants were randomly assigned to either an adapted elaborative interrogation condition or a summary-control condition. All participants were given six arguments to read, which refuted their topic positions. Participants in the adapted elaborative interrogation condition answered adapted elaborative interrogation questions after reading each argument. Participants in the summary-control condition answered summarization and thought-generation questions after reading each argument. After reading, all participants were asked to take position on the CCSS-M topic again and report their topic beliefs again. At last, they were asked to construct argumentation to justify their current position again.

Two scoring rubrics were developed for assessing quality of argumentation in Pilot Study 2. The first scoring rubric was developed based on a continuous scale assessing how well claims are supported by evidence and reasons, as well as coherence of the entire argumentation. The first rubric assessed quality of argumentation on a four-point scale as follows, with a general and/or incoherent argument scored as a 1, a somewhat specific and coherent argument which contained only limited elaboration scored as a 2, a specific and coherent argumentation which contained sufficient elaboration scored as a 3, and a specific, coherent, and convincing argumentation which contained rich elaboration scored as a 4. To examine whether the first rubric was a reliable measure of quality of argumentation, a second rater was trained by the researcher on how to use the rubric to score argumentation in order to calculate inter-rater reliability. The researcher and the second rater independently scored 44 papers (20.6%) of the whole sample which consisted of a pre-test and post-test argumentation for each of the 108 participants (216 writing samples in total).

A second, contrasting rubric was developed based on a sequence of dichotomous checks. The content of each step of dichotomous check was based on extant literature on assessing argumentation (e.g., Wolfe, 2012; Wolfe & Britt, 2008), which focuses on whether claims are supported by evidence/reasons, whether both sides of an issue are incorporated, and the adjudged quality of the evidence/reasons. Based on content of scoring rubrics of argumentation from prior research, the second rubric made dichotomous checks on (1) whether or not there is at least one clear claim in line with the topic position taken (Wolfe & Britt 2008); (2) whether or not claim(s) is/are elaborated with reason(s) or evidence (Berland & McNeill, 2010; Wolfe, 2012; Wolfe & Britt); (3) whether or not the reasons/evidence are relevant and focused (Braten, Ferguson, Strømsø, & Anmarkrud, 2014; Sampson & Clark, 2008); (4) whether or not the elaboration contains specific examples or involves specific context (Tawfik and Jonassen, 2013); and (5) whether or not the opposing position is rebutted (Mateos, Cuevas, Martin, Martin, Echeita, & Luna, 2011; Wolfe; Wolfe & Britt).

The five dichotomous checks were made in the order as numbered above. The score assigned to each argumentation was the number of "yes" responses to these checks, resulting in a possible score range of 0 to 5. For the second rubric, the researcher trained another rater who had not been exposed to the first rubric and the argumentation data before. The researcher and the new second rater independently scored 44 papers (20.6% of the whole sample). Both second raters were doctoral students with background knowledge in CCSS-M and were familiar with the reading materials used. Both second raters were blind to the condition information, subject ID, and pre and post information when scoring.

Results. In Pilot Study 2, 44 out of 108 participants (40.7%) took a pro-Common Core position, while the remaining 64 participants (59.3%) took an anti-Common Core position. This result showed the CCSS-M topic was in fact likely controversial, from the standpoint of the likely college-age participants of the proposed research. Intraclass correlations (ICC) were calculated for scorings based on the first rubric and for scorings bases on the second rubric. The ICC results showed the first rubric scorings had inter-rater reliability judged as moderate (ICC < .6), whereas the second rubric scorings had excellent inter-rater reliability, (ICC > .8), as judged by current ICC literature (e.g., Hallgren, 2012; van Ness, Towle, & Juthani-Mehta, 2008). In addition, based on the second rubric, which has a score range of six points, scorings from the two raters agreed completely on 23 (52.3%) of the 44 papers, and disagreed by 1 point on the remaining papers. There were no disagreements larger than 2 points. In general, these results were taken as indicating that scorings generated based on the second rubric would be more reliable than those based on the first rubric and thus more appropriate for the purpose of the proposed research.

Data analyses based on the second rubric showed: (1) participants in the elaborative interrogation condition demonstrated significantly greater gains in quality of argumentation after reading belief-inconsistent arguments, as compared to participants in the summary-control condition; (2) topic beliefs of participants in the elaborative interrogation condition generally became less extreme and more balanced, and (3) topic beliefs of participants in the summary-control condition did not change. These results suggested the methodological design of exposing participants to belief-inconsistent

arguments of simple structure likely would have enough power for the purpose of primary research study.

Results of Pilot Study 2 also showed the six-point Likert-type scale measure of beliefs on the CCSS-M topic developed by the researcher based on claims from the arguments on this topic had sufficient internal consistency reliability and construct validity, with confirmatory factor analysis showing an acceptable model fit for a two-factor structure of the scale (SRMR = .068, RMSEA = .074, CFI = .930). Cronbach's α was .878 for the pro-CCSS-M factor, and .886 for the anti-CCSS-M factor. Since one of the items in the original scale made the model unable to converge, it was dropped and the scale administered in the main study only contains 11 items.

Decisions about conducting the current research. Several methodological decisions tied to the questions previously posed were also made on the basis of Pilot Study 2 results. First, the CCSS-M topic was selected and the reading materials were comprised of simple-structure arguments (a claims followed by a supporting evidence/reason) on the topic of whether the state should adopt CCSS-M or not. Second, a scoring rubric based on five steps of dichotomous checks was used to assess argumentation quality. Third, participants were only exposed to arguments inconsistent with their beliefs on the CCSS-M topic. Fourth, the researcher-developed six-point Likert-type scale tested in Pilot Study 2 was used in this research to measure individuals' beliefs on the CCSS-M topic.

Research Hypotheses

Based on previous review of relevant literature, it seemed likely elaborative interrogation would have effects of improving argumentation and leading to reflective

belief change, by correcting biased process of belief-inconsistent arguments. It also was judged likely individuals' need for cognition would be positively related to quality of argumentation and might interact with elaborative interrogation. Based on results from the two pilot studies, the reading materials, overall design, and measures tested also seem likely to be sufficiently sensitive to detect effects of elaborative interrogation on argumentation and belief change, as well as the potential role of need for cognition. Thus, the following three hypotheses corresponding to the three research questions posed in Chapter 1 were proposed.

> Hypothesis 1: For participants in the elaborative interrogation condition, quality of argumentation in support of their topic position/beliefs will improve after reading belief-inconsistent arguments. In contrast, participants in the control conditions will not show such improvement.

Elaborative interrogation has been shown to improve associative and inferential learning involved in understanding belief-inconsistent arguments. Several mechanisms suggest these outcomes. First, elaborative interrogation seems to activate prior knowledge and other memory content consistent with the associations and inferences contained in the arguments by engaging participants in deep processing. Second, elaborative interrogation may induce a mental simulation of the to-be-processed arguments and thus contribute to the understanding of the plausibility of the arguments from the perspective of arguers on the sides opposing participants' topic positions. Third, the adapted elaborative interrogation incorporates a prompt for identifying claims and evidence/reasons of the arguments separately, which may facilitate the processing of structure of the arguments and thus add to participants' subjective ease of processing

belief-inconsistent arguments. Considering all these possible mechanisms together, the adapted elaborative interrogation can likely combat confirmation biases that undermine understanding of belief-inconsistent arguments. As a result, as compared with participants' in the control condition, elaborative interrogation may be expected to improve participants' ability to elaborate on their topic positions and integrate and rebut belief-inconsistent arguments based on thorough and accurate understanding of such arguments.

Hypothesis 2: Participants in the adapted elaborative interrogation condition will be more likely to change their beliefs on the topic toward a more balanced and less extreme direction than those in the control conditions.

Since the process of argumentation is conceived of as the cognitive basis for topic belief change or retention, improved argumentation should result in more comprehensive and rational views on the topic based on optimal understanding of arguments from both sides of the issue. Therefore, adapted elaborative interrogation is expected to change participants' topic beliefs toward a more balanced and less extreme direction, as compared with participants' in the control conditions.

Hypothesis 3: Participants with higher need for cognition, as measured by the Need for Cognition Scale, will demonstrate higher quality of argumentation overall. There will be an interaction between need for cognition and adapted elaborative interrogation on improving quality of argumentation.

Since high need for cognition has been found to be associated with deep information processing, objective evaluation of evidence, and motivation to approach argumentation, participants with high need for cognition are expected to demonstrate

higher quality of argumentation. At the same time, participants with different levels of need for cognition are expected to benefit differentially from the adapted elaborative interrogation to improve their argumentation on the controversial topic.

CHAPTER 3

METHODS

This chapter provides a detailed description of the methods used in the current research. It describes the participants, materials, measures, and methods, the examination of treatment implementation, and the procedures used in this research. In general, this study used a mixed model pretest-posttest experimental design with random assignment to three experimental conditions (elaborative interrogation treatment condition, summary control condition, and no-processing control condition) to test the three hypotheses posed. All participants were only exposed to reading arguments on a topic position opposing the topic position they reported at pretest. Data analysis methods utilized in the research are briefly described at the chapter's conclusion.

Participants

Participants of this research were 118 students enrolled in two undergraduate educational psychology courses in a Midwestern university. These participants were from the same population of participants of Pilot Studies 1 and 2. These two courses have a research participation requirement, which students can fulfill either by participating in research studies or writing summaries of educational psychology research articles. Participants of this research were given research credits for compensation. The average age of the participants was 21 years (SD = 2.73). The majority (80%) of the participants were female (n = 92). The majority (86%) of the participants reported their ethnicity as Caucasian (n = 102), with others reporting their ethnicities as African American (n = 2), Asian (n = 1), Latino (n = 3) and multiracial (n = 4). Six participants chose not to report their ethnicity. Fifty-one (51) of the participants (43%) were juniors, 36 were sophomores

(31%), 30 were seniors (24%), and there was only 1 freshman. The majority (65%) of the participants were majoring in education (n = 77).

A power analysis was conducted with effect size derived based on findings from the second pilot study, which was larger but comparable to the effect sizes reported in the elaborative interrogation literature. The result indicated a sample size as large as 108 participants likely could make a beta value of 0.9 available for the current research, while the lower bound of acceptable beta for social science studies is 0.8. Therefore, the eventual sample size was judged sufficient for the purpose of the current study.

Materials

Arguments on the CCSS-M topic were adapted by the researcher from argumentative essays written by in-service mathematics teachers to fulfill an assignment in a graduate-level professional development course at the author's university[1]. Content from these essays were reorganized and reworded to form six arguments supporting adopting the CCSS-M (The Pro-Math Common Core Arguments), and six arguments against adopting the CCSS-M (The Anti-Math Common Core Arguments), see Appendix A. All arguments were structured in the same way, with a claim followed by a reason or evidence supporting the claim. The Pro-Math Common Core Arguments consisted of six arguments, with a total of 598 words. The Anti-Math Common Core Arguments consisted of six arguments, with a total of 594 words.

[1] Classroom materials used with permission of Dr. Wendy Smith of the Center for Science, Mathematics & Computer Education, University of Nebraska-Lincoln

Measures

Self-Reported Topic Position and Argumentation Construction Prompt

The Educational Topic Position and Rationale Questionnaire, which was designed by the author (see Appendix B), provided questions and prompts for participants to report their positions on the CCSS-M topic. This questionnaire consisted of a pre- and post-experiment version (see Appendix B), the wordings of which differed slightly. The pre-test questionnaire began with a two-paragraph written introduction to the CCSS-M topic. Following their reading of this introduction, participants were asked to take a position on the CCSS-M topic by indicating whether they thought the state should adopt the Common Core State Standards for Mathematics. Participants then were asked to write down the point(s) they judged to provide them with the best support for justifying the positions they had taken. The post-experiment questionnaire began with a prompt for participants to reflect on their reading of the belief-inconsistent arguments. Participants then were asked to report their current topic positions. In the end, the questionnaire prompted participants to construct argumentation to justify their current positions one more time.

Scoring Rubric of Quality of Argumentation

The Five-Step-Dichotomous Check Rubric tested in Pilot Study 2 was slightly modified and used to assess quality of argumentation. Raters using this rubric made a series of sequential judgments on whether or not an argumentation possessed each of four features in the numerical order below.

(1) Whether there was at least one clear claim supporting the topic position taken?

(2) Whether the claim(s) was/were elaborated with reasons or evidence?

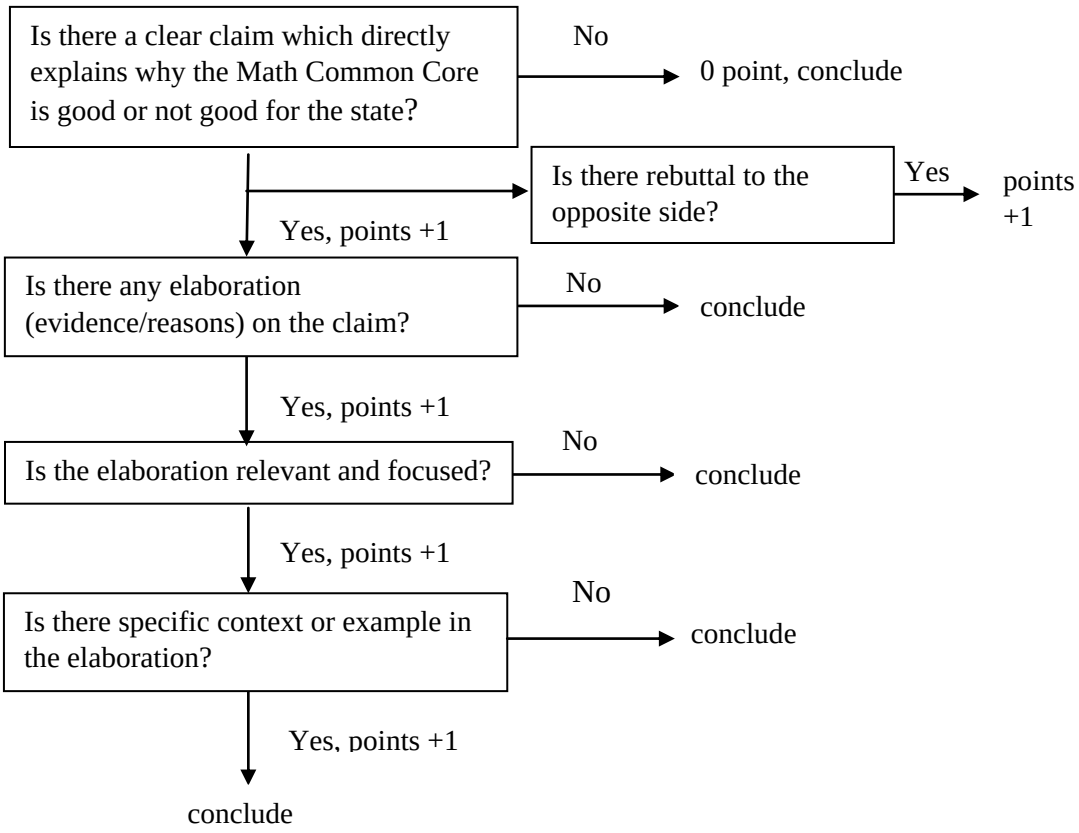
(3) Whether the reasons/evidence was/were relevant and focused?

(4) Whether the elaboration contains specific examples or specific context?

The dichotomous check concluded whenever the answer to a question was “no”. Also, if the response to (1) was “yes,” raters checked whether or not the argumentation possessed some rebuttals to the opposing position.

After all five dichotomous checks were completed, a final score was assigned to the argumentation. The final score was the total number of “yes” responses to all dichotomous check questions. All argumentation scores ranged from 0 to 5. Figure 1 illustrates the detail of each step of dichotomous check in the rubric.

Figure 1. The Five-Step-Dichotomous-Check Rubric.



The researcher was the primary rater, with a second rater trained by the researcher on how to use the rubric to score argumentation. Each of the 118 people produced 2 sets of arguments: pre-test and post-test argumentation. One participant's responses were excluded because the post-test argumentation was missing, so the whole writing sample consisted of 234 argumentations. The two raters scored 21% (n = 50) of the whole sample (n = 234) independently for a reliability check. Twenty-five (25) of the inter-rater sample came from the pre-test argumentation, and 25 came from the post-test argumentation. Both raters were blind to participant identification and condition information when scoring. After independent scoring, the two raters discussed the scoring results and resolved some conflicts, with intraclass correlation used as the index of inter-rater reliability. Since the intraclass correlation between the two raters' scoring for single measure was .845 and is generally considered to be sufficient for empirical studies in the social sciences, (e.g., see Hallgren, 2012), only the primary rater's scoring was used in subsequent data analyses.

Measure of Topic Beliefs

An Educational Topic Belief Scale (see Appendix C) was used to measure participants' beliefs on the CCSS-M topic in both pre-test and post-test. This scale consisted of eleven statements and each statement came from the first sentence (claim) of each of the eleven arguments on Math Common Core, which were from the reading materials used in this study. The reading materials consisted of 12 arguments, but the statement from one argument was dropped from the scale the corresponding item's low loading on the two factors of the scale. This scale was designed to measure how much an individual agrees with each belief central to this topic on a six-point Likert-type scale. As

discussed previously, the scale theoretically would be expected to contain a pro-CCSS-M factor and an anti-CCSS-M factor. An example item from the pro-CCSS-M factor was "Having a national curriculum would be an opportunity for federal and state educational dollars to work more efficiently". An example item from the anti-CCSS-M factor was "Adopting a national standard will undermine diversity that is at the very heart of the United States". In the current study, results from confirmative factor analysis did in fact show very good model fit for a two-factor structure of the scale (SRMR = .058, RMSEA = .053, CFI = .950). Reliability analyses also showed sufficient internal consistency within each factor. Cronbach's alpha was .739 for the five items representing the pro-CCSS-M factor, and .718 for the six items representing the anti-CCSS-M factor.

Need for Cognition Measure

As described previously (see also Appendix D), the Need for Cognition Scale (NFC) was designed and refined by Cacioppo and colleagues to measure how much individuals enjoys intellectually challenging situations and are motivated to engage in effortful cognitive activities on a five-point Likert-type scale (Cacioppo & Petty, 1982; Cacioppo, Petty, & Kao, 1984). Cacioppo et al. (1984) has reported excellent reliability ($\alpha > .90$) and a single-factor structure for this scale. Several studies also have been reported in support of the convergent and discriminant validity of the scale (see a review by Cacioppo et al., 1996). The short form of NFC, consisting of 18 items, was used in this research to measure participants' need for cognition. An average score of the 18 items was used as the indicator of participants' level of need for cognition.

Treatment Implementation

In order to further examine participants' cognitive effort when reading belief-inconsistent arguments with versus without using elaborative interrogation, participants were asked to report the level of difficulty they experienced when responding to questions following each argument, if any. Participants' subjective difficulty level was assessed by themselves on a 10-point scale with 1 being "extremely easy" and 10 being "extremely difficult". Participants' responses to this question ranged from 1 to 9 points (n = 115, M = 4.7, SD = 1.816), indicating a perception of medium difficulty level on average.

Procedures

To test the three hypotheses proposed for this study, a mixed-model experimental design was adopted with a pre-test and a post-test of the two dependent variables, which were quality of argumentation and topic beliefs. Participants were randomly assigned to three conditions: an adapted elaborative interrogation treatment condition (n = 38), a summary-control condition (n = 39) and a no-processing (business-as-usual) control condition (n = 40). Responses from one participant out of the 118 participants were excluded from the analysis because the post-test argumentation was missing. Participants individually completed pre-test measures, arguments reading, question answering, and post-test measures on QUALTRICS, a web-based data collection platform (Qualtrics, Provo, UT), on computers in a quiet computer lab. For all conditions, the data collection procedure consisted of four phases and was completed between 1 to 1.5 hours on average. Below is a detailed description of the above procedures. Also, Appendix G illustrates the procedures with a flowchart.

Pre-Test Phase

Participants first completed the Need for Cognition Scale (Appendix D), Education Topic Belief Scale (Appendix C) and then the Pre-Test Topic Position and Justification Questionnaire (Appendix B (a)). In response to the Pre-Test Topic Position and Justification Questionnaire, they were introduced to the CCSS-M topic, prompted to take positions on the topic and construct argumentation to justify their positions.

Experimental Manipulation Phase

Participants were randomly assigned to one of the three conditions: an adapted elaborative interrogation treatment condition, a summary-control condition, and a no-processing control condition. Participants were asked to read six arguments which opposed the position they just took in the pre-test phase, no matter which condition they were assigned to. For instance, participants who took a pro-CCSS-M position read six anti-Math Common Core arguments (Appendix A(b)) and those taking an anti-CCSS-M position read six pro-Math Common Core arguments (Appendix A(a)). Participants were provided with blank sheets for free-form note taking, if they chose to take notes.

After reading each of the six arguments, participants in the treatment condition were asked to respond to a claim versus evidence/reasons identification question (e.g., Please briefly identify the claim of Argument 1 and the evidence/reasons used to support this claim.) and two elaborative interrogation questions (e.g., Why do you think the evidence/reasons supports the claim? Why do you think Argument 1 justifies that the state should/should not adopt the Math Common Core?). The full set of questions appear in Appendix E. Participants in the summary-control condition were asked to summarize the main idea of each argument and write down at least one thought they had when

reading each argument (see Appendix F). Participants in the no-processing control condition simply read the six arguments without being asked to perform any writing task. All participants had access to the arguments and their notes (if any) when responding to the questions (if any).

Post-Test Phase

After reading and question answering, participants were asked to complete the same Education Topic Belief Scale (Appendix C) again and the Post-Test Topic Position and Justification Questionnaire (Appendix B(b)). In response to the Post-Test Topic Position and Justification Questionnaire, they reported their post-reading topic positions and then constructed argumentation to justify their post-reading positions.

Debriefing phase

After completing all post-test measures, participants were debriefed on the purpose of this study and exposed to the six arguments consistent with their pre-test positions on the CCSS-M topic, which they had not had access to before the debriefing phase. Participants were also given either the adapted elaborative interrogation questions or the summary-control questions, or both of these questions, depending on which condition they were in, to make sure all participants had equal access to all materials used after completing the experiment.

Data Analysis

One-way ANOVA were used to test Hypothesis 1 and Hypothesis 2, for making between-group comparisons. A change variable of argumentation was calculated by post-test argumentation score minus pre-test argumentation score, to examine improvement or deterioration in quality of argumentation. Change variables of topic beliefs were also

calculated by post-test topic belief scores minus pre-test topic belief scores, to examine possible belief change. With regard to Hypothesis 3, correlation analysis was be used to examine the relationship between need for cognition and the pre-test quality of argumentation. Also, regression analysis with an interaction term between the two independent variables, namely experimental condition and need for cognition, will be used to examine whether need for cognition interacts with the experimental manipulation on affecting quality of argumentation.

CHAPTER 4

RESULTS

The current chapter presents results of the research organized around the three research hypotheses previously posed. Additional analyses also are reported in this chapter to provide further insights into results which either confirmed or rejected the research hypotheses. These additional analyses include analyses of treatment fidelity, presence of rebuttal in pretest versus posttest argumentation, and self-reported position certainty and topic relevancy.

Hypothesis 1

Hypothesis 1 posited participants in the elaborative interrogation condition would demonstrate improvement in argumentation quality from pretest to posttest. Table 1 shows descriptive statistics of pretest and posttest argumentation scores for each experimental group.

Table 1.

Pretest and Posttest Argumentation Scores by Condition.

		Pretest		Posttest	
Condition	N	M	SD	M	SD
Elaborative Interrogation	38	2.66	1.02	3.05	.93
Summary Control	39	2.90	1.14	2.69	1.08
No-Processing Control	40	3.03	.83	2.75	1.03

Note: N = 117.

To test whether the random assignment was successful, one-way analysis of variance (ANOVA) was first performed to compare the pretest argumentation score across the elaborative interrogation (EI) treatment group, summary control group, and the no-processing control group. There was no significant difference found among the three

groups on pretest argumentation score [F (2, 114) = 1.33, p = .27], which can be interpreted the random assignment was successful and the three groups had equivalent argumentation writing skills on the CCSS-M topic prior to the experimental manipulation as measured by the scoring rubric.

In order to test Hypothesis 1, the argumentation change score was calculated by subtracting each participant's pretest argumentation score from his/her posttest argumentation score. A positive change score indicated improvement in argumentation from pretest to posttest, and a negative change score indicated deterioration in argumentation from pretest to posttest. Table 2 shows the descriptive statistics of argumentation change score for each group.

Table 2.

Argumentation Change Score by Condition (Posttest - Pretest).

Condition	N	M	SD
Elaborative Interrogation	38	.39	1.05
Summary Control	39	-.21	1.15
No-Processing Control	40	-.28	.85

Note: N = 117.

Next, a one-way ANOVA was performed to compare the argumentation change score across the three groups. The experimental conditions (EI, summary, no-processing) were used as the independent variable or factor in the analysis, with argumentation change score as the dependent variable. It was found the three groups differed significantly on how much their argumentation quality improved or deteriorated from pretest to posttest [F (2, 114) = 4.99, p = .01, η^2 = .08]. Also, it can be seen from Table 2 the EI group was the only group for which the argumentation quality increased after the

experimental manipulation, as indicated by a positive argumentation change score. Both the summary-control group and the no-processing control group showed deterioration in argumentation quality as indicated by negative argumentation change scores. The between-group difference was significant and showed medium to large effect size, as indicated by an η^2 value of 0.08.

In order to further explore the source of the general between-group difference in argumentation change score, post hoc pairwise between-group comparisons were conducted. Results are presented in Table 3.

Table 3.

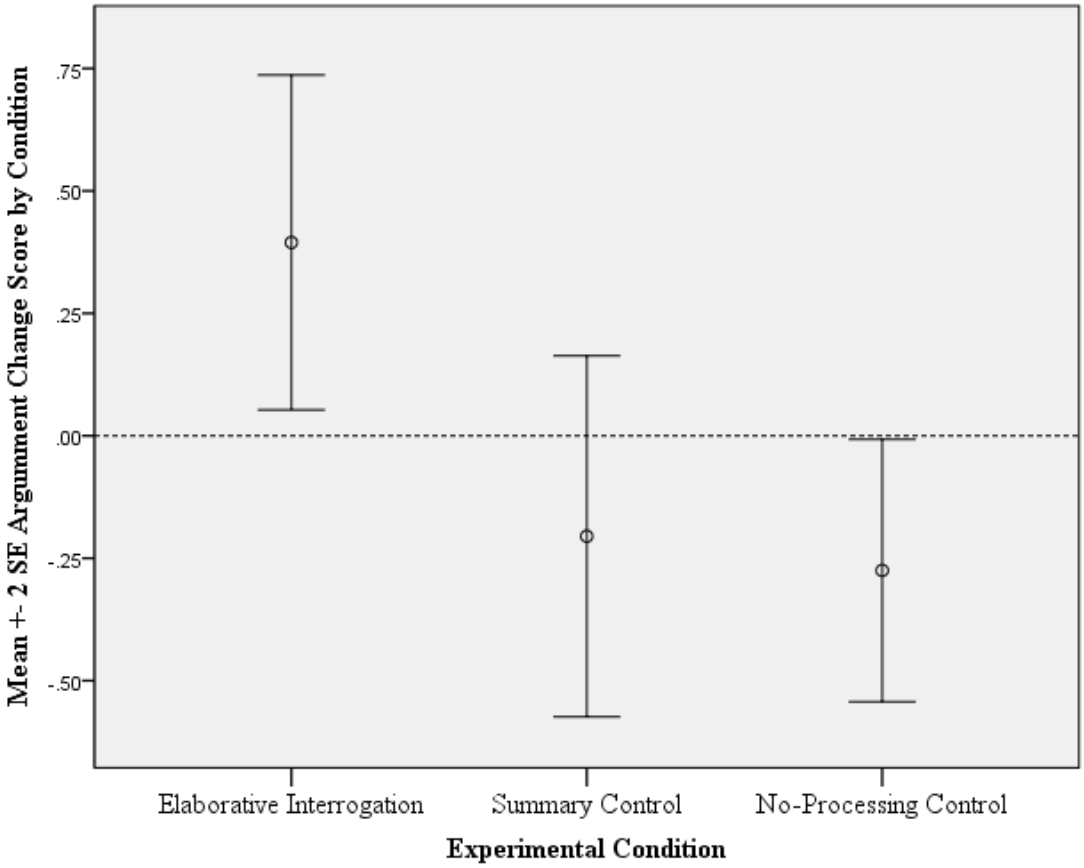
Pairwise Between-Group Comparisons of the Argumentation Change Scores.

Condition A - Condition B	Mean Difference	p value
Elaborative Interrogation - Summary	.60	.01
Elaborative Interrogation - No Processing	.67	.01
Summary - No Processing	.07	.76

Note: N = 117.

As can be seen in Table 3, the EI treatment group had significantly higher argumentation change scores than both control groups. However, the two control groups did not show any significant difference on the argumentation change score. Figure 2 below shows the mean argumentation change score for each of the three groups.

Figure 2. Means of Argumentation Change (Posttest minus Pretest) Scores with Standard Errors by Condition.



In sum, as can be seen in mean changes in argumentation presented above, Hypothesis 1 was confirmed; the treatment group did in fact show greater gain in argumentation score after answering the adapted elaborative question during reading as compared with the summary-control group and the no-processing control group, for whom the argumentation score dropped after the experimental manipulation.

Hypothesis 2

According to Hypothesis 2, participants in the treatment group were expected to demonstrate a more balanced belief after the experimental manipulation, whereas those in

the control groups would not demonstrate such pattern of belief change. To test Hypothesis 2, change variables were computed to reflect the within-subject difference of pretest and posttest belief scores as measured by the Educational Topic Belief Scale. Since there was a pro-CCSS-M (pro-CC) factor and an anti-CCSS-M (anti-CC) factor, a change variable was calculated for each of the belief factors by posttest belief item average score on the factor minus pretest belief item average score on the same factor. This means for EI participants, those who took a pro-CC position at pretest should have a negative pro-CC belief change score (pro-CC belief decreases after the experimental manipulation) and a positive anti-CC belief change score (anti-CC belief increases after the experimental manipulation). In the same sense, EI participants who took an anti-CC position at pretest should demonstrate an opposite pattern in the belief change score, namely a positive pro-CC belief change score and a negative anti-CC belief change. By contrast, participants in the control groups would not demonstrate such a pattern on their belief change scores. Table 4 and Table 5 present the means and standard deviations of the belief change scores for participants in the three groups, providing the basis for an exploration of the general pattern in the actual data.

Table 4.

Belief Change Score for Participants with a Pretest Pro-Common Core Position (N = 49).

		Pro-Common Core Belief Change		Anti-Common Core Belief Change	
Condition	N	M	SD	M	SD
Elaborative Interrogation	18	-.20	.46	.29	.63
Summary Control	16	.00	.69	-.48	.77
No-Processing Control	15	.11	.60	-.10	.56

As can be seen in Table 4, the pattern of belief change in the EI group was consistent with the prediction of Hypothesis 2, with belief changes in the two control groups in the opposite direction. Therefore, the belief change score pattern in participants who took a pro-CC position at pretest is consistent with Hypothesis 2.

Table 5.

Belief Change Score for Participants with a Pretest Anti-Common Core Position (N = 67).

		Pro-Common Core Belief Change		Anti-Common Core Belief Change	
Condition	N	M	SD	M	SD
Elaborative Interrogation	20	.34	1.07	-.02	.46
Summary Control	23	.02	.68	.18	.39
No-Processing Control	24	.17	.57	-.01	.61

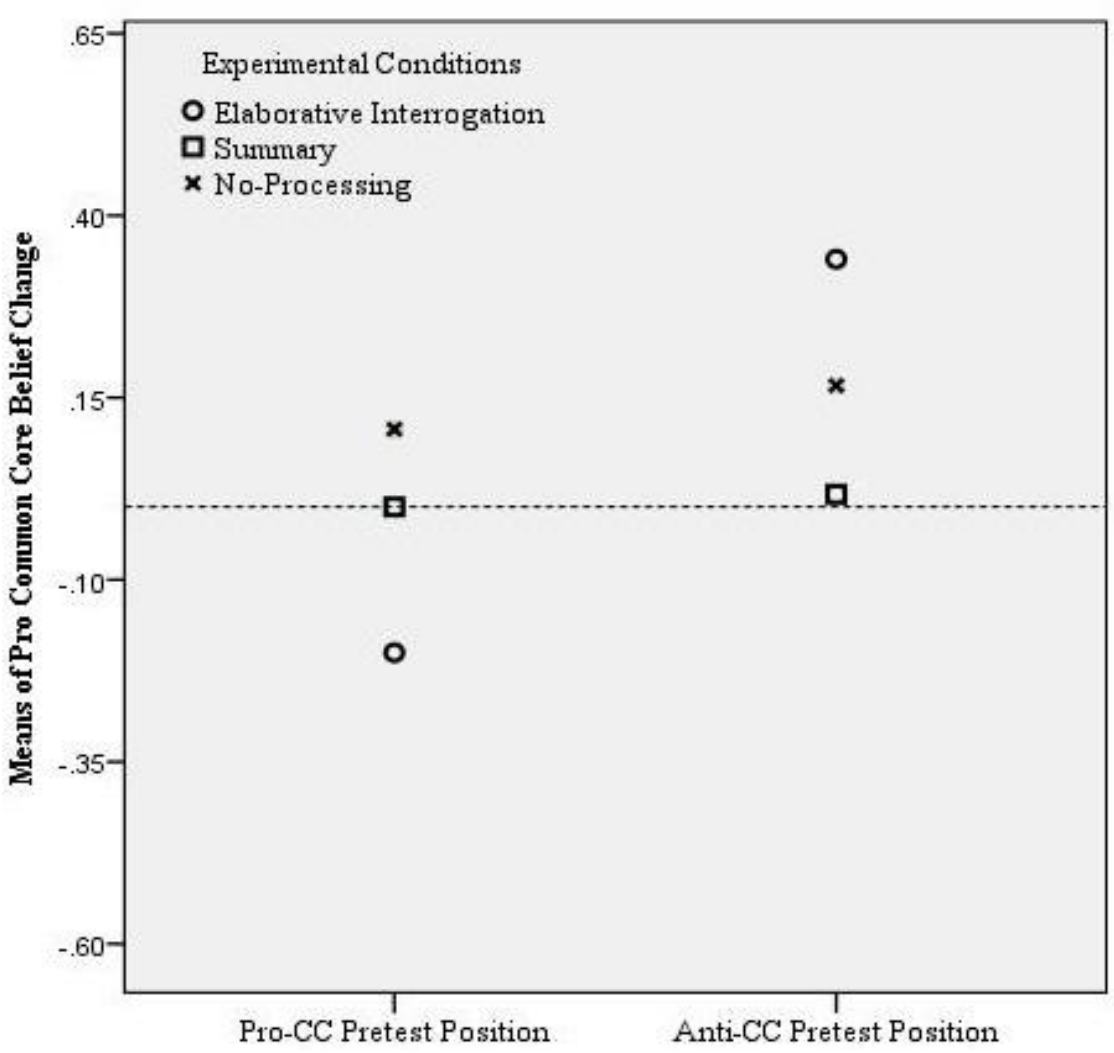
As can be seen from Table 5, the pattern of belief change in EI group was consistent with the prediction of Hypothesis 2, with a pattern of belief change score in the two control groups in the opposite direction. Therefore, the belief change score pattern in participants who took an anti-CC position at pretest supported Hypothesis 2.

In order to examine whether the above patterns were significant as an outcome of the experimental conditions and the pretest positions, further analysis was conducted. Since the two outcome variables were significantly and negatively correlated ($\rho = -.216$, $p < .05$), MANOVA was conducted on the data with experimental condition and pretest position as two between-subject independent variables, and the pro-CC and anti-CC belief score as two dependent variables.

Results from the MANOVA showed the main effects were not significant for either independent variable. Specifically, for the experimental condition, $p = .212$, and

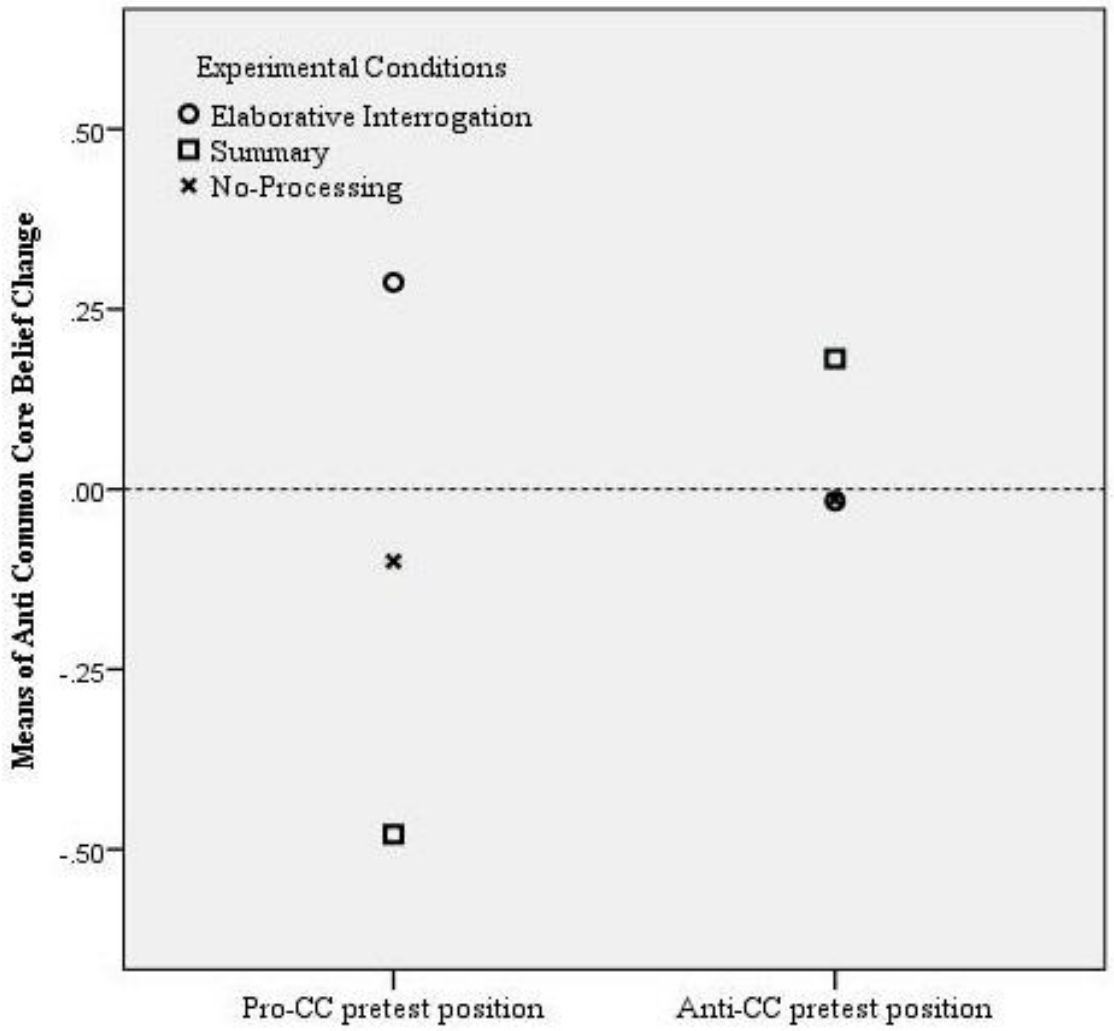
partial η^2 = .026. For the pretest position, p = .070, and partial η^2 = .048. However, the interaction effect between experimental condition and pretest position was significant, with p = .007, and partial η^2 = .062. Specifically, the test of between-subject effects showed the interaction effect was significant for the anti-CC belief change score, with p = .002, and partial η^2 = .109. This finding was consistent with the prediction of Hypothesis 2, since the value of belief change score should not solely depend on condition or solely depend on pretest position. For participants with a pro-CC pretest position, their pro-CC belief change score should be both negative and the lowest in the three groups. For participants with an anti-CC pretest position, in contrast, their pro-CC belief change score should be both positive and the highest in the three groups. Figure 3 illustrates the means of pro-CC belief change score of each experimental group for each pretest position, which was consistent with the above predictions.

Figure 3. Means of Pro-Common Core Belief Change Score by Condition and Pretest Position.



For participants with a pro-CC pretest position, their anti-CC belief change score should be both positive and the highest in the three groups. For participants with an anti-CC pretest position, their anti-CC belief change score should be both negative and the lowest in the three groups. Figure 4 presents the means of anti-CC belief change score of each experimental group for each pretest position, which was in consistency with the above predictions.

Figure 4. Means of Anti-Common Core Belief Change Score by Condition and Pretest Position.



Therefore, based on the analyses results, the hypothesis—participants who responded to the adapted elaborative interrogation questions after reading each belief-inconsistent argument did demonstrate more balanced topic beliefs after the treatment, whereas participants in the control groups did not show such pattern of belief change—was confirmed.

Hypothesis 3

Hypothesis 3 stated participants with higher need for cognition would demonstrate higher quality of argumentation overall and there would be an interaction between need for cognition and the treatment of adapted elaborative interrogation on improving quality of argumentation. To test Hypothesis 3, correlational analyses were conducted on the whole sample among four variables: need for cognition, pretest argumentation score, posttest argumentation score, and argumentation change score. Table 6 presents the results.

Table 6.

Correlation among Need for Cognition, Pretest Argumentation Score, Posttest Argumentation Score and Argumentation Change Score (Post Minus Pre)

Variables		1	2	3	4
1. need for cognition		-			
2. pretest argumentation score		-.08	-		
3. posttest argumentation score		-.08	.46***	-	
4. argumentation change score		.02	-.51***	.53***	-
	M	3.23	2.89	2.83	-.03
	SD	.57	1.02	1.02	1.06

Note: N = 116. *** p < .001

According to the results, need for cognition was not correlated with any of the three argumentation outcome variables. The only significant correlations existed among the pretest, posttest argumentation score, and the argument improvement score. To further examine whether this lack of correlation between need for cognition and the argumentation variables in the whole sample was a result of differentiated correlation due to the experimental manipulation (e.g. Participants in the treatment group may

demonstrate a stronger relationship between their need for cognition and argumentation scores as affected by the EI treatment), correlation analyses were also conducted respectively in the subsample of EI participants, the subsample of the summary-control participants, and the subsample of the no-processing- control participants. Tables 7, 8, and 9, respectively, show these results.

Table 7.

Correlation among Need for Cognition, Pretest Argumentation Score, Posttest Argumentation Score and Argumentation Change Score (Post Minus Pre) for EI Participants.

Variables		1	2	3	4
1. need for cognition		-			
2. pretest argumentation score		-.06	-		
3. posttest argumentation score		-.08	.42***	-	
4. argumentation change score		-.02	-.60***	.48**	-
	M	3.24	2.66	3.05	.39
	SD	.60	1.02	.93	1.05

Note: N = 38. ** p < .01. *** p < .001.

Table 8.

Correlation among Need for Cognition, Pretest Argumentation Score, Posttest Argumentation Score and Argumentation Change Score (Post Minus Pre) for Summary Control Participants.

Variables		1	2	3	4
1. need for cognition		-			
2. pretest argumentation score		-.13	-		
3. posttest argumentation score		-.04	.46**	-	
4. argumentation change score		.08	-.56***	.48**	-
	M	3.21	2.90	2.69	-.21
	SD	.59	1.14	1.08	1.15

Note: N = 39. ** p < .01. *** p < .001.

Table 9.

Correlation among Need for Cognition, Pretest Argumentation Score, Posttest Argumentation Score and Argumentation Change Score (Post Minus Pre) for No-Processing Control Participants.

Variables		1	2	3	4
1. need for cognition		-			
2. pretest argumentation score		-.16	-		
3. posttest argumentation score		-.14	.61***	-	
4. argumentation change score		-.02	-.25	.62***	-
	M	3.23	3.03	2.75	-.28
	SD	.53	.83	1.03	.85

Note: N = 40. *** p < .001.

It can be seen the results from the correlation analyses on the three subsamples showed similar pattern to the results from the whole sample, need for cognition was unrelated to any of the three argumentation scores. Thus, Hypothesis 3 was rejected according to these results.

Additional Analyses

Treatment Fidelity

As previously described in Chapter 3, in order to provide additional information about the efficacy of the experimental treatment, a 10-point scale self-report question was included in the posttest measures for participants to rate the level of difficulty participants experienced during reading and question-answering (if any), with point 1 being "extremely easy" and point 10 being "extremely difficult". The participants' actual responses to this question ranged from 1 to 9, with a mean of 4.70 and a standard deviation of 1.82, indicating a perception of medium difficulty level on average. In order

to examine whether participants from different experimental conditions experiences differentiated level of difficulty to complete the experimental tasks, a one-way ANOVA was performed to compare their responses to this question across the three groups. The result showed the between-group differences was marginally significant ($F = 2.684$, $p = .073$). The results of pairwise comparisons between every two groups showed the EI participants reported significantly higher perceived difficulty level than participants in the no-processing control group (Mean Difference = .964, $p = .022$). In addition, the EI participants' reported perceived difficulty level was also higher than the participants in the summary-control group (Mean Difference = .484), but this difference was not significant ($p = .250$).

The above results thus generally indicate responding to EI questions indeed can lead to greater subjective difficulty as compared to not answering any questions, suggesting participants in the treatment group had exerted greater cognitive effort as a result of answering the EI questions. Further, the non-significant difference between the EI group and the summary-control group suggested answering the EI questions did not impose significantly greater cognitive load as compared to answering summary questions. Since the EI questions were designed to facilitate deep processing without overwhelming the participants by imposing too much cognitive load, such results validated the design of the experimental materials had achieved its goal in the actual experiment.

Presence of Rebuttal in Pretest versus Posttest Argumentation

Since the EI questions were designed to help readers better process and understand belief-inconsistent arguments in order to develop rebuttals to these arguments, it was judged potentially informative to examine the proportion of participants who did

integrate rebuttal in their argumentation in both pretest and posttest. A between-group χ^2 test was conducted to examine whether the number of rebuttals differed across groups. The test was not significant. Table 10 presents the numbers and percentages of participants in each group who integrated rebuttals into their argumentation at pretest and at posttest.

Table 10.

Pretest and Posttest Comparisons of Occurrence of Rebuttals in Argumentation.

Conditions	N	Pretest frequency	Pretest %	Posttest frequency	Posttest %
All participants	117	14	11.4%	42	34.1%
Elaborative Interrogation	38	6	15.8%	14	36.8%
Summary group	39	7	17.9%	11	28.2%
No processing	40	1	2.5%	17	42.5%

It can be seen from the results, in general, more participants included rebuttal to the opposing position in their argumentation in posttest than in pretest. This pattern was consistent across all experimental groups, which may suggest simply exposing participants to belief-inconsistent arguments had the effect of prompting participants to construct rebuttal to explicitly address arguments supporting positions opposing to their own. Also, such results suggested exposing writers to belief-inconsistent information may be an effective strategy to increase the awareness of opposing positions and the rationale of these position such that writers may be more likely to rebut to the opposing positions during the construction of argumentation.

Self-Reported Position Certainty and Topic Relevancy

In both pretest and posttest, participants were asked to report how much they were certain their position was correct and to rate the degree to which the CCSS-M topic was relevant to them personally on a 5-point scale. Such information was judged to provide insights into the strength of participants' prior beliefs, whether participants were motivated to engage with the topic in both reading and writing, as well as on the extent to which these two factors were correlated. Descriptive analysis showed most participants were quite certain about their position at both pretest (M = 3.76, SD = .830) and posttest (M = 3.73, SD = .967). Also, the CCSS-M topic was seen generally as quite relevant to most participants at both pretest (M = 3.93, SD = 1.179) and posttest (M = 3.97, SD = 1.136). Both position certainty and topic relevancy stayed relatively stable from pretest to posttest. A further correlational analysis was then conducted on these variables, which is presented in Table 11. Responses from all 118 participants were included in the analysis since there was no missing data as relevant to the correlation analysis.

Table 11.

Correlation among Pre and Post Position Certainty and Topic Relevance.

	1	2	3	4
1. Pretest certainty	-			
2. Pretest relevancy	.31***	-		
3. Posttest certainty	.30***	.17	-	
4. Posttest relevancy	.24**	.84***	.20*	-
M	3.76	3.93	3.73	3.97
SD	.83	1.18	.97	1.14

Note: N = 118. * p < .05 level. ** p < .01. *** p < .001.

As can be seen in Table 11, topic certainty and topic relevancy were positively correlated with each other at both pretest and posttest. For such results, one possible explanation is, participants who reported higher personal relevancy of the topic had learned more and thought more about the topic as well as their positions on it, such that they may have become quite certain the position they took was correct. Another possible explanation is, participants who reported higher topic relevancy held the truth of the topic more closely to their own identities such that it was important for them to report higher certainty about their topic position. However, since most of the participants were undergraduate students who had not been working as professionals in education for a long time, the identity-based explanation may not be as likely as the knowledge-based explanation.

CHAPTER 5

DISCUSSION

Introduction

The overarching goal of this study was to examine the potential of using adaptive elaborative interrogation as a cognitive strategy and mechanism for combating cognitive biases, both in learning new information and demonstrating prior knowledge. The study's specific purposes were threefold. First, this study examined whether an adapted elaborative interrogation treatment can be used as a remedy to confirmation bias by improving individuals' ability to construct argumentation to defend their positions on a controversial topic, by helping create better understanding of belief-inconsistent arguments. Second, this study focused on testing whether adapted elaborative interrogation might help individuals develop less extreme and more balanced views on a controversial topic. Since such pattern of belief change can be seen as an indicator of attenuated confirmation bias, the second purpose was in line with the first one that examines the potential of elaborative interrogation to be used as a remedy of confirmation bias. Third, this study had the goal of exploring the impact of cognitive motivation, namely need for cognition, on quality of argumentation, as well as examining possible interactions between individuals' need for cognition and the elaborative interrogation treatment.

A randomized experiment with pre-test and post-test measures was conducted to test the research hypotheses. All participants were randomly assigned to either a treatment (adapted elaborative interrogation) condition, a summary-control condition, or a no-processing control condition. All participants also reported their positions on the

controversial topic of whether CCSS-M should be adopted in the state and wrote up argumentation at both pre-test and post-test to justify their positions. After pre-test and prior to post-test, all participants were exposed to six arguments opposing their pre-test topic positions, each designed to represent a simple claim-evidence/elaboration structure. A scoring rubric was developed by the researcher of the study to assess quality of argumentation on aspects relevant to the treatment. The improvement or deterioration in quality of argumentation was gauged by calculating the difference between post-test and pre-test argumentation scores based on the rubric.

To measure beliefs about the CCSS-M topic, the researcher developed a scale based on the arguments used as reading materials of the experiment. Change in topic beliefs was assessed by calculating the difference between post-test and pre-test item-average score on each of the two factors (pro-Common Core factor and anti-Common Core factor) of this beliefs scale. Finally, the Need for Cognition scale (Cacioppo & Petty, 1982; Cacioppo, Petty, & Kao, 1984) was used to measure participants' need for cognition, with individuals' average score on all items on this single factor scale used for data analysis.

The experimental results confirmed Hypothesis 1 and 2, showing an elaborative interrogation treatment was effective both for improving quality of argumentation and attenuating extreme topic beliefs after reading belief-inconsistent arguments. Hypothesis 3, however, was rejected, with no significant correlation found between need for cognition and quality of argumentation. There also was no interaction between the experimental conditions and need for cognition in terms of effects on quality of argumentation.

Comparisons to Previous Research

Findings from this study are consistent with previous research findings on elaborative interrogation in general, in that elaborative interrogation was observed to improve understanding of belief-inconsistent arguments. Thus this study expands the research findings on the positive impact of elaborative interrogation on learning of arbitrary facts and inferential learning of well-established knowledge. Specifically, findings from the current study suggest elaborative interrogation can be used to facilitate balanced understanding of arguments reflecting different perspectives to improve construction of argumentation and form less extreme views on a controversial topic. In other words, this study has shown elaborative interrogation can help writers construct argumentations to justify their own position and attenuate their beliefs on an issue the truth of which is uncertain or unknown.

This study differs from previous research on elaborative interrogation in that it suggests a new potential of this learning strategy—that of being useful as a remedy to certain cognitive biases. As indicated by post-test topic beliefs which were more balanced on average as compared to the pre-test beliefs in participants from the treatment group, as well as their improved argumentation, it can be argued this study's treatment can help attenuate confirmation bias. Given that the majority of participants retained their pre-test topic position, such results can be taken as meaning that individuals' positions on the controversial topic may be supported by thinking that is more rational after the experiment than before. In this sense, this study suggests new perspectives on future research using elaborative interrogation as a cognitive strategy. To better articulate this new perspective, the remainder of this chapter provides discussion specific to findings on

each research hypothesis, the overall implications and limitation of this study, as well as suggestions for future research.

Discussion of Hypothesis 1: Effects of Adapted Elaborative Interrogation on Argumentation Quality

In light of the current experimental results, it can be seen the method of adaptive elaborative interrogation may have potential as an effective strategy for improving argumentation construction on controversial topics by combating confirmation bias against belief-inconsistent information. Adaptive elaborative interrogation's potential as a confirmation-bias remedy can be analyzed from two cognitive perspectives. First, adaptive elaborative interrogation may improve learning of belief-inconsistent arguments. Second, by prompting more balanced and thorough memory search, adaptive elaborative interrogation may also enhance demonstration of the knowledge and skills needed to construct quality argumentation on a controversial topic.

With regard to improved understanding of belief-inconsistent arguments, participants' responses to the "why" questions of elaborative interrogation may provide a cognitive support for participants to identify and reflect on the relationship between claims and evidence/reasons in belief-inconsistent arguments. As shown by their improved argumentation scores, participants in the treatment group were more likely to come up with better elaboration and to include rebuttals in their argumentation. These findings would seem to strongly suggest the process of answering "why" questions may have two separate types of cognitive effects.

The first type may be based on the increased chance for participants in the treatment group to examine the elaboration contained in each belief-inconsistent

argument just as they were trying to justify the logic tying a claim to its evidence/reason. Such processes seem likely to increase participants' chances to examine their own elaborations when writing argumentation justifying their post-test topic position. This may have led to improved articulation of evidence relevant to the claim, as demonstrated by the improved quality of argumentation. In addition, since the elaborative interrogation treatment used in this study involved a "why" question on the relation between each belief-inconsistent argument and the topic position it purported to support, participants in the treatment group also may have had an increased chance to contemplate which arguments most effectively supported their own topic positions. This process may have contributed to increasing the relevance of their own arguments as justification of their topic positions, which was measured by the scoring rubric used.

The second positive effect of elaborative interrogation on cognition may be due to increased awareness of belief-inconsistent arguments. For participants in the treatment group, being prompted to deeply reflect on the belief-inconsistent arguments may have made it less likely for these participants to ignore or distort the real meanings of these arguments as compared to participants in the control groups. Also, exerting mental effort to justify the relationship between the claim and evidence/reasons in a belief-inconsistent argument may also decrease the chance of shallow processing of belief-inconsistent arguments. As can be seen from the additional analysis in Chapter 4, greater pre-post increase of rebuttals was found in argumentations constructed by the treatment group, as compared with the summary-control group. It also should be noted it is possible simply exposing individuals to belief-inconsistent arguments may increase the chance of rebuttal

integration in argumentation construction, as suggested by the large increase of number of rebuttals from pretest to posttest in the no-processing control group.

In sum, it would seem the positive effect of adapted elaborative interrogation on improving quality of argumentation can be at least partially attributed to its effect on improving the learning of belief-inconsistent arguments. It also might be further argued, however, such effects may partially be the product of improved memory search tied to the treatment facilitating demonstration of topic understanding. As described in Chapter 2, confirmation bias not only leads to shallow processing of external information, but also can result in superficial examination and retrieval of existing memory content. When participants were answering the elaborative interrogation questions, however, it may have become more likely for them to create a mental simulation to account for the plausibility of belief-inconsistent arguments. Such mental simulation could have facilitated more balanced and extensive memory search on both sides of the issue, thus contributing to the depth and sufficiency of argumentation constructed.

Discussion of Hypothesis 2: Effects of Adapted Elaborative Interrogation on Topic Beliefs

The effect of elaborative interrogation of attenuating confirmation bias is also indicated by findings related to Hypothesis 2, which posited participants in the adapted elaborative interrogation treatment group were expected to report more balanced and less extreme topic beliefs after the experimental manipulation. For both the pro-Common Core position and anti-Common Core positions, participants in the treatment group reported more balanced and less extreme topic beliefs after the experiment. By contrast, control group participants reported less balanced, more extreme topic beliefs. Such

findings would seem to provide intriguing evidence that elaborative interrogation might be used as a remedy to confirmation bias, and mechanisms underlying such effects may be similar to those underlying its positive effects on improving argumentation quality.

First, the mental simulation possibly activated by answering "why" questions may have provided an opportunity for participants to reflect on the plausibility of beliefs opposing their own view. Second, the treatment also may have made information favoring beliefs opposing participants' own views more available during the enhanced memory search. Third, the treatment seems likely to have facilitated deeper processing and thus made the opposing beliefs more understandable to participants, which together may have led to less extreme topic views even as they still retained their previous topic positions. In general, rational beliefs should be based on sufficient evidence/reasons, sound logic, and deep thinking on both sides of the issue. Therefore, as a result of attenuated confirmation bias, more balanced and non-extreme beliefs can be seen as flexible and adaptive, since such beliefs should be more likely to be open to future evidence, discussion, and environmental change.

Designs for Adapting Elaborative Interrogation

Based on this study's findings and above discussions regarding the confirmation of Hypothesis 1 and 2, it would seem the adaptive elaborative interrogation strategy tested in the current research might have broader impacts on quality of argumentation and topic beliefs. Basically, the adaptive elaborative interrogation in this study had two features that interventions in previous elaborative interrogation studies did not, which may have supported argumentation construction by increasing awareness of how argumentation actually was constructed on a controversial topic.

A first key feature of the current manipulation was including a facilitative question at the very beginning, one designed to serve as a prompt for separate identification of claim versus evidence/reason. This feature is important because, in order to examine the relationship between claim and evidence/reason, one must first establish a clear distinction between these two things. Only after a claim is identified as independent from the evidence/reason, does it become possible to examine the quality of each independently, as well as the relationship between them. Thus, including a prompt question asking participants to distinguish between claim and evidence/reason for each belief-inconsistent argument prior to presenting the "why" question may have contributed to the effectiveness of the treatment.

A second likely important feature was including "why" questions at two different levels of abstraction with regard to the belief-inconsistent reading materials. The first "why" question prompted reflections on the relationship between the claim and evidence/reason of each individual belief-inconsistent argument, while the second prompted reflections on the relationship between each belief-inconsistent argument and the topic position supported by it. A structure combining both lower- and higher-order relationships may be seen as closely resembling the actual structure of argumentation construction, which involves both constructing claims supporting the topic position and providing evidence/reasons bearing on the validity of the claims.

By providing cognitive support specific to the reading materials and experimental task, the design of adapted elaborative interrogation in this study may also have addressed the high cognitive load issue, which often is a negative side effect of the "consider the opposite" approach (Schwarz, Sanna, Skurnik, & Yoon, 2007). The

"consider the opposite" approach typically asks participants to generate possible rationales for the position opposing their views without providing any cognitive support. Therefore, as a result of confirmation bias, participants may find it difficult to generate anything at all to support a view they disagree with, leading to an experience of high cognitive load.

By contrast, the above two features of the adapted elaborative interrogation may have facilitated understanding of each individual belief-inconsistent argument and how it related to the topic position it supported. In aggregate, participants in this study reported lower than medium perceived difficulty of completing the experimental task (mean of 4.7 on a 10-point scale), which indicates participants in general did not experience much cognitive overload. In addition, as discussed by Greene et al. (1996), materials already containing some elaboration may not be appropriate to examine the effect of elaborative interrogation. Since exposing participants to belief-inconsistent arguments only did not give them access to the elaboration on their own topic positions, this research design may have been particularly suitable for observing the effects of elaborative interrogation as a cognitive strategy to improve quality of argumentation.

Discussion of Hypothesis 3: Effects of Need for Cognition on Argumentation Quality

Hypothesis 3, which proposed a relationship between need for cognition and quality of argument, was rejected. No significant relationship was found. There may be several reasons for this negative finding. First, other factors than need for cognition may have stronger impact on quality of argumentation in the context specific to this study. For instance, since need for cognition is conceptualized as an overarching cognitive motivation for individuals to engage in challenging cognitive activities generally, it

seems plausible there might be context-specific motivational factors which could overwrite a general need for cognition. For example, participants may have a strong motivation to defend their pre-existing topic positions regarding whether CCSS-M should be adopted in the state, which may have attenuated or negated the general effect of need for cognition. Also, if some participants were very certain about their topic positions, they may have been strongly motivated to defend their topic position, regardless of their level of need for cognition. Such speculation seems credible given that most participants reported above-average (mean of 3.9 on a 5-point scale) self-relevancy of the CCSS-M topic, which might indicate some context-specific motivation to defend their position. They also in aggregate reported above-average (above 3.7 on a 5-point scale) certainty about their topic positions.

However, since context-specific motivation was not measured in the current study, it can only be concluded further research with a measure of context-specific motivation is needed to provide more direct evidence for the speculation that effects of context-specific motivation may overwrite that of need for cognition as a general cognition motivation. Likewise, participants' prior knowledge on the CCSS-M topic and their argumentation writing skills may be additional factors which had a strong impact on argumentation quality, which may also be speculated to overwrite the impact of need for cognition. Thus, future studies are needed to examine and compare effects of these factors on quality of argumentation to confirm or reject these speculations.

Finally, it is also possible in order for the effects of need for cognition on learning outcome to be observed, the time spent on learning needs to be extended well beyond the time allocated in the current experimental sessions. Since need for cognition reflects an

individual's general tendency to engage in cognitively challenging activities in all contexts, its effects presumably would be more likely to appear in a longer-term intervention involving multiple encounters with the learning materials, rather than in a study involving a single, relatively short learning session. That is, during a long-term learning process, the contexts of learning are likely to vary from one time to another, with need for cognition less easily overwritten or attenuated by the changing contextual factors and thus more readily observable.

Contributions

As compared to previous studies on elaborative interrogation, this study arguably can be seen as making two important contributions. First, this study has provided a new research paradigm for examining the usefulness of elaborative interrogation as a remedy to certain cognitive biases. Whereas prior research on elaborative interrogation has focused almost exclusively on examining its usefulness as a learning strategy for arbitrary facts or higher-order learning based on external input, this study has provided a new perspective for viewing elaborative interrogation as a potential mechanism for facilitating cognitive transformation. As previously discussed, an elaborative interrogation approach may affect both the approach to processing new information and how one searches existing memory content, resulting both in better understanding and improved demonstration of knowing in argumentation construction.

Second, by providing relatively simple adaptations of the elaborative interrogation questions commonly used in previous studies, this study provides an initial response to the issues of high cognitive load or material of high difficulty level which have been considered undesirable for elaborative interrogation to positively affect learning (Clinton,

Alibali, & Nathan, 2016). Thus, adaptations of elaborative interrogation may provide a new way for future research on this cognitive strategy to address the issue of negative side effects on learning outcome, such as high cognitive load, suggesting the probability to have the positive effects of using cognitive strategy more like to be found by adaptive the strategy appropriately.

A further potential of the current research comes from connecting educational research on learning strategies to the psychological research on cognitive bias. Given the positive findings of the present study, it seems elaborative interrogation may have potential as a cognitive remedy to confirmation bias, as indicated by the desirable belief change observed in participants from the treatment group. Admittedly, considerable additional research is needed in a variety of topics and contexts to test the utility of elaborative interrogation for correcting confirmation bias, but results of the current study do suggest possible productive adaptations of an intervention originally designed to improve informational learning. Moreover, the current study proposed and experimentally tested the usefulness of elaborative interrogation to be used as a pedagogy for improving argumentation writing. Since the design and administration of elaborative interrogation questions can be easily adapted to different learning materials or writing topics, there likely is considerable potential for a practical use of elaborative interrogation for writing intervention in a variety of educational settings.

Limitations

The current study has several limitations to be addressed in future research. First, participants of this study were mostly education majors at a large public university. Since the controversial topic used in this study was an education topic, the participants seem

likely to have had greater background knowledge and interest in the content of the topic than other students in this age range. Individuals with a different major likely would have less prior knowledge and personal interest on this topic, which may result in different effect of the treatment if the same materials are used. Thus, findings from this study should be replicated in future studies involving participants with more varied backgrounds to strengthen the external validity of the research findings.

Second, reading materials used in this study consisted of multiple belief-inconsistent arguments, which may have provided information on too many dimensions. Although each argument was designed to possess a simplified structure of a claim followed by some evidence/reason to justify that claim, the reading material still contained several arguments with different claims and evidence/reasons. Reading materials with this design plausibly could make it difficult for participants to focus on one single point to develop sufficient elaboration and rebuttal in their own argumentation construction. Although the present findings showed positive effects of the treatment, whether such materials affected the internal validity of the results remains to be examined by future research.

Future Research

A logical next step for the current research is to examine the effect of elaborative interrogation on argumentation writing with reading materials focused on new topics and varying in length and complexity. As suggested by Dornisch and Sperling (2006), for instance, when individuals are reading longer text, elaborative interrogation may not be effective in facilitating information selection from the text. Also, the effect of elaborative interrogation may not be observed if the information to be learned is derived from

multiple sources (Dornisch & Sperling, 2008). Future research might also present a single argument in the reading material, in contrast to the multiple arguments present in the current study. Also, since individuals with higher prior knowledge are especially likely to benefit from elaborative interrogation (Ozgungor & Guthrie, 2004), further research on this topic should incorporate some measure of participants' level of topic knowledge. Further, it may be profitable to provide standardized prior knowledge training and activation, such as learning or review sessions on topic information prior to experimental manipulation.

It may also be productive in future research to have participants engage in more extensive writing on a longer period of time, which may provide conditions needed for the development of elaboration and demonstration of deep understanding in more extensive argumentation writing. In addition, future research on using elaborative interrogation as an argumentation writing intervention can also integrate social argument, such as debate between participants taking opposing positions, to examine the effect of elaborative interrogation on argumentation constructed in the course of a conversation.

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APPENDIX A: Math Common Core Arguments

Pro-Common Core Arguments

Please read each of the following arguments carefully and respond to questions that follow. You can come back and read these arguments again while you are working on the questions.

Argument 1: Adopting Common Core will improve Nebraska's students' mathematics achievement, while local control of educational standards is not working. The disconnect between Nebraska's 8th grade mathematics NAEP (National Assessment of Educational Progress) results and Nebraska's STARS (School-based Teacher-led Assessment and Reporting System) reported proportion of proficient students over the last decade is strong evidence local control does not increase math achievement. The proportion of 8th grade students reported as mathematically proficient, according to STARS, has grown from 72.34% in 2001-2002 to 91.58% in 2009-2010. However, NAEP scores over the same span of years remained virtually stagnant, hovering with plus or minus four points of 280.

Argument 2: A common standard can create a greater ability for collaboration among educators in creating and revising high quality, content rich lesson plans that can be shared nation-wide. Collaboration on this scale would allow for a repository of materials to be gathered and shared by educators in all content strands. Textbooks would be created and aligned with a common set of standards in mind, allowing for a more cohesive use of publisher-based materials than many districts currently have in place.

Argument 3: Transitioning to the *Common Core* can be seen as an opportunity for federal and state educational dollars to work more efficiently. Focusing these separate funds on a single common goal would eliminate millions of educational dollars being spent by individual states to create standards and curriculum that changes each decade when the impact on student achievement is less than expected. This would allow states to invest more money at the classroom level where it is direly needed. The financial implications of a national curriculum appear to weigh in favor of individual learning.

Argument 4: Adopting the Common Core has the benefit of an increased effort to help close the achievement gap for students with high mobility rates. Those students who move around throughout their educational career, whether they be military families that move across states or even countries, or students who move across town from one school to another within the same district, often develop gaps in their knowledge. This is, at least in part, due to the fact that the curriculum is not the same in all states, and is often not presented at the same grade level or same time of year in every school. When students move, material that had yet to be covered at their former school may have already been taught in their new school, or may not even be introduced at the same grade level. The Common Core can directly address such an issue.

Argument 5: Having the same standards nationwide would potentially contribute to teacher education at the college level. Teaching common standards across the country would allow universities to better prepare pre-service teachers in the specific mathematical content they need to know, and ensure that what they are learning is relevant to what they will need to know in the classroom. For those teachers who attend

college in a different district or state than they end up teaching, this would be a very valuable change in the higher educational system for them.

Argument 6: Adopting national standards assures that students all have the same opportunities when applying for college scholarships or jobs. A national curriculum would provide clear expectations for what teachers should be teaching, so we no longer have to be concerned of teachers teaching what they like, and leaving out things that they do not. To quote another proponent of national standards "this is the UNITED states of America. So, let's unite our standards and licensures for a better education for our students."

Anti-Common Core Arguments

Please read each of the following arguments carefully and respond to questions that follow. You can come back and read these arguments again while you are working on the questions.

Argument 1: Adopting a national standard will undermine diversity that is at the very heart of the United States. We are a country made up of people from diverse backgrounds with diverse needs. Our diversity is our strength. By adopting a national curriculum, we stand against that diversity by mandating that all student needs can be met by the same curriculum. That is not to say the students in Massachusetts are any more or less capable than students in Nebraska, but the needs of those students are in fact different. As it has been shown in Nebraska, it is possible for a state to write comprehensive standards that address needs of all students at all levels.

Argument 2: If a national standard is adopted, not only will states lose one of their primary responsibilities, but teachers will be forced to add more and more topics to their already bloated courses. As the focus turns to teaching to the new standards, all teachers will have no choice but to discard best practices in the name of completion of tasks. Teaching will go from an art to a check list. Already we can see the effect of this in Nebraska, which has adopted very effective standards.

Argument 3: A change to a new national standard at this time would be a dereliction of fiscal responsibility to the citizens of the state. The state of Nebraska devoted a large amount of resources, both time and financial, to development of the current standards. These standards are high quality and targeted to address educational needs specific to this state. The cost of adopting new materials that correlate to the Common Core on the heels of investments in the last year purchased to meet the needs of the new Nebraska curriculum is ludicrous; neither school districts nor the state has the necessary funding available.

Argument 4: We do not really need to use a national standard, since states are capable of coming up with their own standards, which their curriculum matches. Most of the classrooms in the country are using books very similar in scope and sequence. The state tests are written based on the standards of each state which should be pretty close to the same thing so the state tests currently being used are sufficient to examine the progress of schools nationwide.

Argument 5: A national standard does not contribute to students' equal achievements as it claims to. A national standard only address the issue of what to teach, with no answers to how to teach. A teacher with minimal understanding of how to teach

mathematics may provide a rather ordinary learning experience for students in her class. But if the skill set possessed by individual teachers related to the learning of mathematics is solid, the experience in their classrooms may be more dynamic and thus more effective for learners. Until the focus of mathematics reform takes a good, long, hard look at using best practice in the classroom, what standards are adopted will not facilitate the change needed to increase achievement.

Argument 6: The lack of control over the evolution of the Common Core Standards can pose a high risk to education in Nebraska. The Common Core Standards are untested and there is no proof that adopting the Common Core will improve student learning at all. Since there is no the local control over the mechanism of revising and improving the Common Core Standards, the sudden change of replacing current state standards that we have long appreciated with the Common Core is something that we cannot risk.

APPENDIX B: Educational Topic Position and Rationale Questionnaire

Pre-Test

Please read the following information about an educational topic and respond to the questions that follow.

The Common Core State Standards for Mathematics (referred to as "Math Common Core" below) is an education initiative in the United States that details what K-12 students should know in mathematics at the end of each grade. The Math Common Core seeks to establish consistent mathematics education standards across the states. The Common Core has drawn support and criticism from political representatives, policy analysts, and educational commentators. Forty-four of the fifty U.S. states and the District of Columbia have adopted the Common Core. Nebraska is one of the 5 states not adopting it at a state level.

In Nebraska, there has been a controversy over whether the Math Common Core should be adopted. People who support the Math Common Core believe it is better than the current state standard of Nebraska and adopting the Math Common Core would benefit students' mathematics achievement, use of financial resources in mathematics education, educators' collaboration, and teacher preparation. People who are against the Math Common Core believe adopting it would undermine educational diversity in mathematics, deprive Nebraska of control over its mathematics education, lead to a waste of state money, and have no contribution to students' mathematics achievement.

Please think about this issue and describe your position on it by responding to the following questions. Please make sure you take either a pro-Math Common Core or an anti-Math Common Core position (no neutral ground) and indicate how certain your

position is the right one to take. If you are not so sure about your position, rate the strength of your position accordingly.

- Do you think Nebraska should adopt the Common Core State Standards for Mathematics? (mark one)

Yes, I think Nebraska should adopt the Common Core State Standards for Mathematics.

No, I don't think Nebraska should adopt the Common Core State Standards for Mathematics.

- Please rate how certain you are that the position you hold on this topic is right, with 1 being "very uncertain" and 5 being "very certain" (mark one of the numbers below):
- Please rate how relevant this topic is to you personally, with 1 being "highly irrelevant" and 5 being "highly relevant" (mark one of the numbers below):

Now please think about the strongest point(s) you are best able to argue on to justify the position you just take on the topic "Should the state adopt the Common Core State Standards for Mathematics?". Then please write down some arguments to make the point(s) for your position. Please write as extensively as you wish.

Post-Test

Please think about the arguments you just read and your responses to the questions on the arguments. Now please describe your position on this topic by responding to the following questions. Please make sure you take either a pro-Math Common Core or an anti-Math Common Core position (no neutral ground) and indicate

how certain you are that your position is the right one to take, as well as how personally relevant this topic is to you. If you are not so sure about your position, rate the certainty of your position accordingly.

- Do you think Nebraska should adopt the Common Core State Standards for Mathematics? (mark one)

Yes, I think Nebraska should adopt the Common Core State Standards for Mathematics.

No, I don't think Nebraska should adopt the Common Core State Standards for Mathematics.

- Please rate how certain you are that the position you hold on this topic is right, with 1 being "very uncertain" and 5 being "very certain" (mark one of the numbers below):
- Please rate how relevant this topic is to you personally, with 1 being "highly irrelevant" and 5 being "highly relevant" (mark one of the numbers below):

Now please think about the strongest point(s) you are best able to argue on to justify your current position on the topic "Should the state adopt the Common Core State Standards for Mathematics?". Then please write down some arguments to make the point(s) for your position. Please write as extensively as you wish.

APPENDIX C: Educational Topic Belief Scale

Please rate how much you agree with the following claims, with 1 being "strongly disagree" and 6 being "strongly agree".

2. A common standard can create a greater ability for collaboration among educators in creating and revising high quality, content rich lesson plans that can be shared nation-wide. (pro-Common Core)

3. Having a national curriculum would be an opportunity for federal and state educational dollars to work more efficiently. (pro-Common Core)

4. Adopting the Common Core has the benefit of an increased effort to help close the achievement gap for students with high mobility rates. (pro-Common Core)

5. Having the same standards nationwide would potentially contribute to teacher education at the college level. (pro-Common Core)

6. Adopting national standards assures that students all have the same opportunities when applying for college scholarships or jobs. (pro-Common Core)

7. Adopting a national standard will undermine diversity that is at the very heart of the United States. (anti-Common Core)

8. If a national standard is adopted, not only will states lose one of their primary responsibilities, but teachers will be forced to add more and more topics to their already bloated courses. (anti-Common Core)

9. A change to a new national standard at this time would be a dereliction of fiscal responsibility to the citizens of the state. (anti-Common Core)

10. We do not really need to use a national standard, since states are capable of coming up with their own standards, which their curriculum matches. (anti-Common Core)

11. A national standard does not contribute to students' equal achievements as it claims to. (anti-Common Core)

12. The lack of control over the evolution of the Common Core Standards can pose a high risk to education in Nebraska. (anti-Common Core)

APPENDIX D: Need for Cognition Scale (Short Version)

Please rate to what extent each of the following statement describes you on a five-point scale.

1. I would prefer complex to simple problems.

2. I like to have the responsibility of handling a situation that requires a lot of thinking.

3. Thinking is not my idea of fun. *

4. I would rather do something that requires little thought than something that is sure to challenge my thinking abilities. *

5. I try to anticipate and avoid situations where there is likely chance I will have to think in depth about something. *

6. I find satisfaction in deliberating hard and for long hours.

7. I only think as hard as I have to. *

8. I prefer to think about small, daily projects to long-term ones. *

9. I like tasks that require little thought once I've learned them. *

10. The idea of relying on thought to make my way to the top appeals to me.

11. I really enjoy a task that involves coming up with new solutions to problems.

12. Learning new ways to think doesn't excite me very much. *

13. I usually end up deliberating about issues even when they do not affect me personally.

14. I prefer my life to be filled with puzzles that I must solve.

15. The notion of thinking abstractly is appealing to me.

16. I would prefer a task that is intellectual, difficult, and important to one that is somewhat important but does not require much thought.

17. I feel relief rather than satisfaction after completing a task that required a lot of mental effort. *

18. It’s enough for me that something gets the job done; I don’t care how or why it works. *

Notes: * indicates reverse scoring is used on this item.

APPENDIX E: Adapted Elaborative Interrogation Questions

Please briefly identify the claim of Argument 1 (Argument 2/Argument 3/Argument 4/Argument 5/Argument 6) and the evidence/reasons used to support this claim.

Claim:

Evidence/reasons:

Now, please think from the perspective of the person who wrote Argument 1 (Argument 2/Argument 3/Argument 4/Argument 5/Argument 6) and explain:

1) Why do you think the evidence/reasons supports the claim?

2) Why do you think Argument 1 (Argument 2/Argument 3/Argument 4/Argument 5/Argument 6) justifies that the state should/should not adopt the Math Common Core?

APPENDIX F: Summary-Control Questions

Please use your own words to summarize the main idea of each argument.

Argument 1:

Argument 2:

Argument 3:

Argument 4:

Argument 5:

Argument 6:

Please list at least one thought you have when you read each argument.

Argument 1:

Argument 2:

Argument 3:

Argument 4:

Argument 5:

Argument 6:

APPENDIX G: Flowchart of Experiment Procedures