DIGITAL, SCIENCE, AND INFORMATION LITERACIES: AN EXPLORATION IN WAYS ADULTS DETERMINE CREDIBILITY OF ONLINE RESOURCES

by

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(Under the Direction of Thomas Valentine)

ABSTRACT

Adults must possess many skills to access and evaluate credible science-based information on the Internet, especially when the science-based topics are tinged with levels of disagreement or controversy. To navigate these controversial science-based topics, adults need to have digital, science, and information literacy skills. The present qualitative study focused on two controversial science-based topics and used Hilligoss and Rieh's (2008) Unifying Framework of Credibility Assessment Model as the guiding conceptual framework to attend to the following research questions: 1) How do non-science experts define *credible science information*?, 2) What general rules and cues do participants use to select credible science-based websites during an online search?, and 3) How do participants evaluate credible controversial science-based resources found online? Eight adults participated in this qualitative research study.

Real-time search data was collected and analyzed to yield two major conclusions: 1) learners draw from firsthand experiences and experiences of others to assign credibility to online science-based resources and 2) non-science experts proved to be competent in digital, science, and information literacies. Implications from this study provide three strategies for those tasked with disseminating science-based resources online especially when the resources contribute to literature pertaining to controversial science-based tropics such as fracking and climate change. The three strategies indicate the need to 1) internally evaluate online resources, 2) conduct usability study of online resources, and 3) stay dynamic to meet changing adult audience needs, interests, and abilities. Bottom line, constructs used by adults to define credible controversial science-based information are varied and complex. Evaluation of a homogeneous participant group in a specific learning context and focused on two science-based search topics did not yield a "one size fits all" approach to ways in which credible science-based information on controversial topics of fracking and climate change. However, this current research study supports the notion that adults, even non-experts in the subject matter, possess digital literacy skills, science literacy skills, and information literacy skills to make credible resource judgments.

INDEX WORDS: Science Literacy, Digital Literacy, Information Literacy Information Credibility, Adult Learning, Real-time Data, Stimulated Recall Interview, Camtasia Studio, Controversial Science, Fracking, Climate Change

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DEDICATION

A task such as this was not a solo journey. For taking the journey with me, I dedicate this dissertation to the village of loved ones who supported this journey:

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THE PROBLEM

Introductory Vignette

During a recent road trip to the coast of Georgia, the Morgan family drove past a stand of unique trees growing in a saltwater swam. Fascinated with the pencil-like structures shooting up out of the ground around each tree trunk, Mr. Morgan pulled over to snap a quick photo. When the family returned home, his curiosity led him to his computer to learn more about the trees. Booting up his laptop and grabbing the phone he used to take the photo, Mr. Morgan initiated a science-based learning endeavor on the Internet.

Mr. Morgan was an intelligent man who worked in the financial sector. He was not schooled in plant or ecological sciences. He had no specific resource or website in mind when he began his search. He just wanted to learn about the fascinating trees he had seen, and he had a few moments to spare while his daughter, Mary, napped. He opened his laptop, selected a web browsing program and a familiar search engine then typed in the phrase "saltwater trees."

A list of webpage links and images came up in return of his search. Mr. Morgan's search strategy helped him make decisions of which resources he accessed. He skimmed through the search result list and noticed one of the links with the words "tree", "saltwater", and "mangrove" in the brief description underneath. Selecting this link, he found value in the resource as the information was well-organized and contained many images of the tree. Reading on, Mr. Morgan learned the tree was a type of tree known as a mangrove and it played an important role in the environment. He remained on this web-based resource as it presented information clearly for Mr. Morgan to understand. As he continued reading, Mr. Morgan learned about the mangrove's tolerance for saltwater and about the tree's root adaptations since he had been curious on why these roots protruded up from the ground like pencils standing on end and emerging from the earth below. Mr. Morgan kept reading this website, but there was no mention of mangroves in Georgia. Trusting the information he had just read, Mr. Morgan started another search synthesizing the newly learned tree name. He searched for "mangroves in Georgia."

This search yielded numerous links to mangrove information from other parts of the world. Unfortunately, those were not salient to what Mr. Morgan was wanting to find. He continued to scroll through the search results list and scrolled to the bottom of the first page of search results *which listed a Wikipedia resource indicating the search terms "mangroves" and "Georgia" would be included. His mind flashed back to his experience in a freshman biology class when the biology professor threatened point deductions on an assignment for all students who used Wikipedia as a source as Wikipedia was comprised of user-generated information that had not been fact checked and was added by anybody, knowledgeable or not. Shaking the school memory, he selected Wikipedia since he was not in school anymore and was merely searching out of curiosity.*

The Wikipedia site had detailed pictures and easy to read text helping Mr. Morgan identify the tree as a black mangrove. In further reading, he learned these trees grew as far north as Georgia and could live in saltwater habitats. He felt this search had been successful as he found a specific name of the tree and verification of its presence in Georgia. Feeling excited to learn more, Mr. Morgan typed in another search string, "black mangrove roots," and found an official academic source, a University of Florida resource which described the peculiar roots, known as pneumatophores, and discussed their importance in supplying oxygen to the roots in times that high water covered the lower roots. Processing this information, his thoughts were abruptly interrupted as he heard his daughter cry for him from another room. He closed the Internet browsing window, shut down his laptop, and went to tend to his daughter's needs. As impromptu as it had begun, Mr. Morgan's science-based online learning episode on those fascinating black mangrove trees had ended.

Reflection on the Vignette

The above vignette is a hypothetical situation based on actual, common, brief learning episodes experienced by adults in today's digitally connected society. Each day, adults observe something in the world around them through experiences, news, social media, friends, or family. These observations, specifically science-based observations, oftentimes create questions. Adults become curious to answer their scientific inquisitions and take advantage of the Internet and various digital tools like laptops and smart phones. These adult learners, often called self-directed adult learners, are interested in learning and use the Internet to retrieve scientific information to conduct learning episodes. During these episodes, adults make many fast-paced judgments to evaluate resource credibility and resource relevance during their searches. Judgments of credibility would not be an issue if Internet resources were all credible, but the Internet has countless science-based resources containing information with questionable credibility. Adults interested in learning science online should be aware that Internet-based information can be erroneous, incidentally or intentionally. Many science-based topics, especially those industrial practices in areas such as petroleum and fossil fuel consumption, tend to be affiliated with disagreements, or controversies in the scientific community; thus, presenting conflicting or controversial information left to the lay person to interpret and evaluate. Such controversial science-based information can be challenging to evaluate as many adults might not have critical evaluation skills or the scientific interest to evaluate credible controversial science information.

While one degreed or working in a science-based field, a science expert, might readily distinguish credible resources versus non-credible resources. Individuals not degreed or employed in the scientific field, referred to in this study as non-science experts, might lack critical evaluation skills. Lacking skills such as digital literacy, science literacy, and information literacy, could prevent them from adequately evaluating the credibility of science-based resources causing them to integrate non-credible information into their science-based learning experiences. Synthesis of non-credible information can have negative impacts. Not only does non-credible information cause dissonance in future learning endeavors, but acceptance of non-credible information has potential to impact health, wealth, or civic responsibilities of adults since science weaves through so many aspects of our daily lives.

In the vignette presented at the beginning of this chapter, Mr. Morgan, a non-science expert, faced many decisions in his science-based online learning episode. He initiated a question, formulated search terms, evaluate the lists of available resources, determined information saliency, and synthesized newly acquired information to guide the direction of his search. This non-science expert used science literacy, digital literacy skills, and information literacy skills to access, read, comprehend, and evaluate scientific resources in a self-directed manner. For instance, he questioned the use of Wikipedia as a resource in this learning endeavor due to his prior college experience with his biology professor and his awareness that use-generated content can be erroneous. But, he threw caution to the wind and used Wikipedia during this science-based learning episode. Mr. Morgan critically evaluated the information he encountered and, although brief, was able to navigate web-based resources to develop a response to the questions he sought.

While learning about coastal trees requires levels of digital literacy, science literacy, and information literacy, learning about controversial science-based topics requires a greater level of the tripartite literacy skills. Exploring, in real-time, how adult navigate Internet-based controversial science resources and assign credibility to the resources would indicate a deeper understanding to sciences that have been catapulted into the sociopolitical arena.

Adults have a plethora of experiences impacting their learning and their learning strategies. Oftentimes self-reported data is flawed as it differs from the real-time data. Research generating real-time data on how adults go about conducting a science-based information search and assigning credibility to those resources would provide data not influenced by the self-reporting snares. This present study contributes to literature regarding how adults, specifically those who are non-science experts, evaluate credible science-based information found on the Internet. Data for this study was collected in real-time and explored with each participant in a follow-up interview focused on the real-time search data. The remainder of this chapter further discusses the research study's application and presents the statement of the problem, my personal orientation to the research, the purpose statement, research questions, and research significance to the field of adult education.

Application to the Research Study

When adults engage in a self-directed online learning episode, they must sort through unprecedented amounts of information lacking sponsorship or proof of authorship (Warnick, 2004). With each resource encountered, adult learners must decipher fact from fiction which can be problematic as the Internet contains a large amount of misinformation (Calvert, 2001) whether made available intentionally or accidentally (Piper, 2000). Without some level of online publication vetting system, or a "universal standard," adults can have a challenging time in determining resource credibility as anyone can write and publish information shared through the online environment (Metzger, 2007, p. 2078).

Information and misinformation are abundant on the Internet. The amount of information versus misinformation is directly linked to the subject matter at the center of an adult's online search. For instance, research indicates when an adult goes online to learn more on medical issues, the learner encounters information that is "unregulated and of questionable accuracy" (Matthews, Camacho, Mills, & Dimsdale, 2003). Poor quality medical information might cause danger to the learner's health. At another time, adults, like Mr. Morgan mentioned earlier in this chapter, who enjoy learning as a hobby and go online to learn about local flora and fauna, might not encounter controversy or questionable information. And, at another instance, a civic minded adult might search for Internet-based information on a controversial scientific topic, such as hydraulic fracking, before voting in an election. Given the controversial nature of the topic, information encountered during this search might be more bias than factual.

Misinformation of science comes in many forms, some more innocent than others. When designing web-based science content, meaning and facts are altered purposefully or accidentally. For instance, shortening long science-based articles to fit into the available space, can alter the entire meaning or not present details necessary for understanding. Other times, the meaning of research is incidentally altered as communication staff attempt to increase readership or make science subjects more "sexy." Or, misinformation can be attributed to a communication disconnect between the scientist and the layman when the research is not presented in a way for non-science experts to understand. There are countless other ways and reasons for the prevalence of misinformation on the Internet, but the above discussion highlighted a few examples to illustrate the complexity of deciphering science-based resources encountered on the Internet. Learning online is complex and adults need to have literacy skills to learn about controversial science-based content.

Many online resources have been crafted intentionally to deceive. Adults who learn online should possess critical evaluation skills to navigate and select credible resources during their online learning endeavors. Whether assimilating erroneous or non-credible science information causes one to purchase the wrong perennials for their area or sign away mineral rights of their land, adults face repercussions when not capable of discerning credible and non-credible science-based information. While repercussions to assimilating non-credible science information might not surface immediately, repercussions in assimilating misinformation or non-credible information into one's set of truths might cause dissonance when the misinformation is identified through a subsequent learning episode.

Science can be a difficult subject to learn. Controversial science can be exponentially difficult to learn when a non-science expert sits transfixed on a computer screen that has connected her or him to an overwhelming global resource pool. Adults must navigate the dueling voices of information and evaluate resources to assign credibility. Self-directed adults engaging in controversial science-based learning episodes are ultimately required to possess levels of competencies in scientific literacy, digital literacy, and information literacy skills if they are undertaking science-based searches on the Internet. Identifying how adults select credible science-based resources when learning about these controversial topics can provide insight to those individuals and agencies tasked with disseminating science-based information.

Statement of the Problem

Most adult learning endeavors are self-directed, self-regulated, and autonomous. So, a generalized statement can be made in which most adults are self-directed learners (SDL) as they select the topic, the way in which they learn, and the learning outcomes. Currently, most adults conduct their learning endeavors online. Because of this independently regulated media, most adults are now facilitating their learning as they decide when learning has happened, and they take full control in selecting the resources used in their learning episodes. This proves problematic in the realm of controversial science-based topics as adults conducting these online learning episodes require critical evaluation skills to navigate complex scientific content, yet many adults engaged in these learning endeavors are non-science experts. Not only are many of these adults simultaneously learning new science content, but they must learn how to interact with the learning context. This online science-based learning endeavor is faced with challenges as adults assimilate new content knowledge while executing various levels of digital competencies. There is a need for adult learners to possess basic skills in science literacy, digital literacy, and information literacy so they can successfully locate and engage with credible science-based information while conducting on online information search.

Research is focused on integrated technology in a formal classroom setting (Jones, Scanlon, & Clough, 2013), but research geared on audiences not situated in this context is lacking. Much research exists on ways in which school-aged children or collegiate courses navigate the interface of science literacy, digital literacy, and information literacy. However, little to no research is available regarding how adults navigate this interface when searching for credible controversial science-based resources. Schwier (2010) stated "it is time for research and educational technology to make a serious and sustained effort to understand informal learning in technology-based environments" (p. 92), but to date research has not been focused on the informal learning context created when a self-directed adult learner initiates a science-based learning episode on the Internet.

Many years ago, Mocker and Spear (1982) discussed the need for research on the interaction of human and nonhuman resources and how this relationship affects the learning process. In researching the literature, I found literature regarding studies on formal self-directed adult learning settings like what would occur in a college of professional training setting. Many resources surfaced pertaining to research on how online information was presented and perceived in the areas of medicine, health, consumerism, and travel. However, little literature could be located addressing the adult populace and how they go about learning about scientific inquiries for enjoyment, on their own time, at their own self-directed pace, and out of curiosity. More specifically, research on how these adults were learning about controversial topics like climate change and fracking was all together lacking. Likewise, real-time research on how resource selection and credibility judgments were made when learners were confronted with conflicting information on the same controversial topics. More research and literature are needed to explore how adults, specifically those classified as non-science experts, navigate and make judgments on these controversial science-based resources they encounter during on online learning episode. Real-time research would prove best in capturing actual decisions and reducing errors in memory and speculation. Through such research, decisions on how adults make resource credibility decisions could be garnered as well as an operationalized definition of "credible science information."

One promising angle to investigate ways in which non-science experts evaluate resource credibility of online controversial science-based information is the Unifying Framework of Credibility Assessment model published by Hilligoss and Rieh (2008). This framework considers the learning context, experiences, current epistemologies, and interactions with the learning medias. The framework is discussed thoroughly in the coming chapter and has provided the skeleton on which this present study has been situated.

Purpose Statement and Research Questions

The purpose of this study was to examine the ways in which adults, specifically non-science experts, identified credible online science-based information during real-time Internet searches. The study specifically examined the interface of science literacy, digital literacy, and information literacy as participants are asked to identify credible science-based information through real-time Internet searches. Research was guided by the following questions:

1. How do non-science experts define *credible science information*?
2. What general rules and cues do participants use to select credible science-based websites during an online search?
3. How do participants evaluate credible controversial science-based resources found online?

This research explored how adults define credibility as it relates to science information and this present study captured how participants evaluated online scientific information on controversial topics of interest to them. Participants searched for information and then recalled their rationalization in decision making during a follow-on stimulated recall interview. This study garnered valuable real-time data collected as adults explored online science-based resources and provided evidence on how they evaluated credible scientific information.

Personal Orientation to the Research Study

Teaching is in my blood and science is in my heart. As a professional environmental educator and research scientist, I am driven by the curiosity of scientific inquiry and the desire to be a reflective, effective educator meeting my audiences at their skill and interest levels. Research interests to conduct this present study grew from prior professional experiences from several adults I encountered between 2003-2007 during various professional development workshops. These adults stated feelings of being left behind when the mass migration of science-based resources went from tangible to virtual. They reported frustration and disappointment in not being able to locate resources or access the resources once located.

Around this same time, many science communication and education facilities were shifting their science-based resources historically in print form to digital forms only available online. Printing budgets at these facilities were often slashed, spaces once offering public access to these printed materials were absorbed into exhibits or offices, and QR code (Quality Response code) readers became necessary for visitors to install on one's smart phone in order to access science information at local museum and aquaria. This was an exciting time in which resources could reach wider audiences, yet this shift created great personal conflict. I wanted to go main stream and adopt these "new, cool, trendy" practices, but I feared this shift to virtual education would create a deeper chasm between those with digital skills and those without. A chasm between those with financial resources to own the digital tools and those without. A chasm between those knowing others who could assist with questions and those who did not. Someone needed to work with adults and see how science literacy, digital literacy, and information literacy interacted when these adults conducted an online learning episode. Research was needed to determine if adults were finding these resources and if they were deeming them useful, understandable, credible.

Through this research study, I wanted to investigate how adults undertook a scientific learning episode on the Internet when tasked to look for complex, controversial subject matter. I wanted to focus on their real-time navigation selections and identify the resources they used, discuss the rationales behind their research, and determine how they approached controversial topics outside the realm of their everyday life. My hope was evaluating how non-science experts evaluated online scientific resources in a real-time manner would provide data for those tasked with disseminating science-based, controversial or not, resources on the Internet. Adults must leave formal school settings with skills in digital media and science. These skills assist them when they make credibility judgments on resources with which they engage, and it is important to understand how they are coming to their decisions on resource credibility and how their skillsets assist or impede them.

Findings from this research provided a starting point for further exploration of the interface of digital literacy, science literacy, and information literacy for science-based SDL episodes. While this section provided my personal orientation to the research discussing how I came to this research space. The next section provides the significance of this real-time data collection strategy and research to the fields of adult education, science communication, and beyond.

Significance

Real-time data generated by adults engaged in an online scientific-based search can impact literature and practice in many fields, from adult learning to science education to science communication. Findings from this study are relevant to educators, scientists, organizations, higher education facilities, or others who might disseminate science-based information through the Internet to adult audiences. Theoretical findings from this research add to the literature on constructivism in the digital age and how adults make meaning of new scientific topics through digital learning platforms.

While literature on digital literacy, science literacy, information literacy, and information credibility were abundant, there was a lack of research available where these themes intersected. For instance, literature pertaining to digital literacy is readily available, but tended to focus on non-adult audiences or digital competencies adults exhibited in a formal setting. Literature on science literacy, again focused on non-adult audiences and formal contexts. This body of literature seemed focused on the efforts and achievements of the formal K-12 science literacy standards rather than science literacy advancements of the adult populace. Information literacy research identified the need for critical examination of information and discussed the notion of credibility and ways in which adults define this construct.

Given the duality of experiences when learning online, I approached the research design and data analysis in a constructivist perspective. Constructivism states meaning is constructed by an individual based on their experiences. Wilson (1983) indicated one's experiences can be either firsthand, experienced by self, or secondhand, experienced by others. Incorporating prior experiences into meaning making allows for a more personal enriched learning experience (Papert & Harel, 1991). Assuming this perspective in this study's research design seemed most logical especially when dealing with two dynamic fields, science and technology.

At the time of writing, most research available pertained to the non-adult audiences, non-formal contexts or different subject matter. Literature also indicated most of research on credibility and the tripartite literacies utilized quantitative methodologies instead of qualitative methodologies, or garnered data based on participants' self-reports rather than in real-time. Lastly, frameworks for these prior studies assumed different conceptual frameworks to guide the research design and data analysis. The present study focused on a specific audience (non-science expert adults aged), a specific learning context (the Internet), a specific subject matter (controversial science) and collected real-time data which was held to a constructivist perspective in research design and data analysis.

The present study proved significant as it added to the literature on the intersection of digital literacy, science literacy, information literacy, and the adult populace. The present study continues the conversation of how adults define credibility and how adults are identifying credible science-based information in the digital age. This initial chapter provided the foundation for my research by identifying the problem, the purpose, the three guiding research questions, my personal orientation to the research, and the research significance. The next chapter, Chapter Two, contains discussion of the literature reviewed for the development of the research. More specifically, Chapter Two provides discussion of the four pertinent literature strands providing the foundation of my research.

CHAPTER 2

REVIEW OF THE LITERATURE

Introduction

The impacts of digital technologies on adult educative endeavors have been documented in literature for over thirty years. For instance. in 1982, Darkenwald and Merriam stated that the "rapid technological and social change has direct consequences on the future of adult education" (p. 4). Digital learning technology continues to evolve and constantly impact education efforts in formal, informal and non-formal contexts. How are these changes impacting adult learning? More specifically, how are these changes impacting the science-based learning endeavors adults conduct on the Internet? Adults interested in learning on their own, also known as self-directed learners, must possess skills necessary to conduct a learning endeavor. These skills include, basic computer skills or digital literacy skills. These self-directed learners engaging with an Internet based science learning endeavors, must possess a basic understanding of science processes, commonly referred to as science literacy skills.

Further still, these adults must possess a level of criticality in examining resources as many scientific topics popularized in the media have become politicized, polarized, controversial. Self-directed adult learners must be able to distinguish credible and non-credible resources when learning on these controversial issues. These adults must have a level of information literacy. Meaning adults initiating an online science-based learning episode must be digitally literate, scientifically literate, and skilled in discerning credible and non-credible information, which is known as being information literate. This trifecta of literacy skills assists adults in discerning credible science information, thus empowering these adults. Hiemstra and Brockett (1994) advocated the need for empowering adults so they take responsibility for their learning. One way this can be done is to equip the adults with the tripartite literacy skills so they can locate and evaluate information encountered while conducting a self-directed online learning endeavor for science-based information.

The following chapter presents and discusses literature pertinent to the strands of this present qualitative research study: self-directed adult learners, digital literacy, science literacy, information literacy, and information credibility. The chapter begins with an introduction and discussion of literature pertaining to self-directed learning in the adult populace, then segues into literature focused on digital literacy, specifically research focused on the Internet-based learning platform. Afterwards, literature discussion turns to scientific literacy, or science literacy, and its increased demand in today's learning society. Lastly, literature on information literacy is presented along with discussions of various models used to assess information credibility. For the sake of this study, the selected literature focuses on studies situated in an informal or non-formal context. This chapter concludes with implications of the literature for my research study and identification of the gap in which my work is situated.

Today's Adult Learner: Self-directed and Connected

Knowles (1980) focused on the idea of knowledge becoming outdated in one's life time. He urged adults to be learners for their lifetime and not rely on the education from childhood to carry them through adulthood. In this idea of lifelong learning, Knowles (1980) offered a new concept of *andragogy* and posited adults learn differently than children and adults learn differently greatly than other adults due to an array of accumulated life experiences. These accumulated lifelong experiences influence how decisions are made during the learning process (Wilson, 1983). Cross (1981) supported Knowles' concept of andragogy and the idea of continued learning throughout one's lifetime. Cross (1981) added a notion of adults seeking learning opportunities on a self-directed basis when needing to resolve problems. When adults could not find resources to solve the identified problem, additional problems arose for the learner (Cross, 1981).

Adults learn due to societal change and societal pressures. This learning pressure was noted many years ago as Houle (1961) stated that

> within the context of lifelong learning, self-directed learning is one key way in which people keep up with change and, since we are currently experiencing an unprecedented level and pace of change on a global scale, it is plausible to expect the demands of a changing world to lead to greater amounts of self-directed learning (p. 4).

Technology and society continue to change, and adult learners continue to conduct self-directed learning endeavors. These adults must navigate complex learning platforms and equally complex learning topics. In the following section, literature regarding self-directed learning, a primary style of learning for adults, and the shifting learning landscape is discussed.

Self-directed Learning Overview

The concept of self-directed learning (SDL) has been around since the mid 1800's with the creation of lyceums and community groups (Brookfield, 1983). In fact, Brockett and Hiemstra (1991) encouraged educators to think of SDL as a lifelong learning approach as discussed years earlier by Knowles (1980). SDL "can occur in a wide variety of situations, ranging from teacher-directed classroom to self-planned and self-conducted learning projects" (Guglielmino, Long, & Hiemstra, 2004, p. 1). Research has estimated "up to 80 percent of an adult's learning efforts, consists chiefly of self-planned learning and is ignored by professionals in the field" (Brookfield, 1983, p. 34). Adults of today's digital society are learning outside of the traditional brick and mortar establishments and technological devices serve as a main conduit for information.

While some literature alters the term *self-directed learning* to *self-direction in learning*, many sources use the terms interchangeably. For this study, *self-directed learning (SDL)* is used to represent both bodies of literature. Considered as one of four types of lifelong learning examples, SDL can be defined as a learner having control over the learning objectives and the ways in which they learn these learning objectives (Mocker & Spear, 1982). Mocker and Spear (1982) presented self-directed learning as a skill for all learners given its autonomous nature. In 1991, Candy supported the autonomous learning approach as he discussed SDL occurring when the learner manages their own learning with control of the learning environment without any input from a formalized agent.

Candy (2004) realized SDL often occurred when an adult was learning for fun which, he noted, should not undermine the worth of the learning experience. Candy (2004) stated that self-directed learning "is often erroneously equated with the trivial, inconsequential or self-indulgent pursuit of hobbies or other specialized interests" (p. 3) yet, "in its truest form, self-directed learning is a wellspring of individual expressions: it is the unfettered pursuit of interests dictated by one's personal values and aspirations" (p. 44). Candy's explanation of SDL is highly applicable to today's adult learners and the amount of learning they are conducting at the touch of their fingertips. Just like the learning episode from the vignette in the previous chapter, SDL endeavors take place spontaneously, for an unspecified amount of time, and randomly based on a learner's current interest.

Shifting Learning Platforms for Self-directed Learners

Tough (1979) stated that "changes in society will, in turn, result in people learning certain knowledge and skills are not common at present" (p. 42). When he conducted his study over forty years ago, adult learning episodes included films and television programs viewed in the privacy of one's home. These medias were thought to be "new ways of learning" (p. 120). While these are not new ways of learning by today's standards, there are new ways in which information is being delivered and new learning platforms engaging adults in SDL endeavors.

SDL has been an active research focus in the United States since 1930 and continues to be an important research focus given the advances in digital learning technologies, specifically regarding learning occurring in nonformal and informal capacities (Guglielmino et al., 2004). Research now indicates the Internet is replacing traditional sources of information (Takahashi & Tandoc, 2015), such as printed newspapers. "Our ability to keep pace with [technology] for learning is a measure of our ability to move with the times and to address adult learners' needs" (Irving & English, 2011). Learning on the Internet encourages more learners to engage with learning opportunities in a self-direct manner (Garrison, 2003). SDL's autonomous nature has been an integral part in expanding the digital learning landscape. Digital learning options seem designed to support SDL and a self-directed adult learner (Candy, 2004).

"Learning for educational purposes is more than simply assessing information and participating in chat rooms" (Garrison, 2003, p. 48). Adults need to possess skills allowing them to find and access resources, but also skills and knowledge enabling them to critically evaluate information when learning online (Garrison, 2003) as these critical evaluation skills can assist adults in finding credible resources (Wiley, Goldman, Graeser, Sanchez, Ash, & Hemmerich, 2009). In today's learning environment, adult learners are now expected to approach a self-directed science-based learning endeavor with knowledge of digital tools (digital literacy), knowledge of the science content (science literacy), and critical thinking skills to evaluate online resources (information literacy).

An adult learner can connect to a vast cloud of information suspended in cyberspace at virtually any time and any place. Connectivity with digital devices is growing in popularity and becoming a large component to the adult education field, especially in the realm of informal and self-directed learning (Irving & English, 2011). While the Internet may offer many benefits to adult learners, there are many barriers to consider as well. In the following sections, literature pertaining to the literacies identified as necessary in science-based self-directed learning episodes is discussed. These areas include digital literacy, science literacy, information literacy.

Digital Literacy

In today's adult populace, adults are making many decisions with the Internet as their primary, and often, solo information source. Those interested in reaching adult audiences should pay attention to the adult learning-digital interface. Poynton (2005) stated the presence of digital tools is changing how adults do business and live their lives. Poynton's (2005) research is supported by more contemporary research indicating three fourths of adults learn online for personal growth or to assist others in their lives (Horrigan, 2016). For over the last forty years, literature has encouraged educators to understand the notion of adulthood as a factor in the learning process to facilitate learning (Darkenwald & Merriam,1982). Learning in adulthood has shifted as have access to resources.

Adults are growing more engaged with digital tools and technology thus relying more on their digital literacy skills to find and access resources. This shift in learning platforms has caused self-directed learners to migrate from simply *learning* to becoming the *facilitator of their learning* (Irving & English, 2011). Recognizing this shift, it continues to be imperative that adult learners are equipped with digital literacy skills and competencies, so they can shift roles to navigate and access online resources (Mocker & Spear, 1982). Digital literacy skills simply mean adults are knowledgeable in use of digital technologies. These skills allow them to locate, communicate, and share information through online environments, such as the Internet, email, and the World Wide Web (WWW) through a computer or hand-held mobile devices (Irving & English, 2011). Over the last few decades of evolving technologies, informal learning resources for adults have shifted from reading the printed newspaper, interacting with fellow community members, listening to the radio (Roberson & Merriam, 2005) to searching Internet websites, interacting with blogs, and downloading podcasts. With this shift in learning platforms, there are benefits and barriers for the adult learners.

Digital Benefits and Barriers

Adults engage in self-directed learning (SDL) through online environments. Research indicated many reasons on why adults access the Internet. The primary goals were informational searches and transactional searches (Hughes, Wareham, & Joshi, 2010), yet research indicated the Internet provides opportunities and challenges for learners (Song & Hill, 2007). Digital tools needed to access online environments provide many benefits, yet, at the same time, these tools and online learning platforms afford many barriers, real or perceived. The following section discusses the selected literature identifying these benefits and barriers for adults engaged in SDL through online environments.

The Benefits. In today's digital age, research has indicated an increase in technology access and popularity. Computers are more commonplace and no longer “special tools of the ‘nerd elite” (Berry, 2001). Almost every home has some form of a computer, including tablets, smart phones, etc. In fact, research indicated growth in computer ownership and prevalence of computer use has virtually closed the gender gap on computer use (Poynton, 2005). As adults increase connectivity to online resources, they potentially conduct SDL endeavors allowing access to an unlimited virtual network of information and resources irrelevant of the topic of interest (Candy, 2004; Karakas & Manisaligil, 2012).

The online environment offers adults convenience in learning (Mamary & Charles, 2000; Roach & Lemasters, 2006) through the use of mobile technologies (Bonk, 2010). Additionally, online learning provides the abilities to learn as a group or to learn asynchronously (Greenhow, Gibbons, & Menzer, 2015). Adults can now self-pace their learning in formal online learning environments as well as non-formal learning environments (Song & Hill, 2007). Online learning platforms provide a flexible personalized location, and a more cost-effective manner than traditional learning endeavors (Mamary & Charles, 2000; Metzger, 2007).

Adults with digital literacy skills can navigate and learn through the online environment benefitting from these skills that allow them to search for information “effectively and efficiently” (Hargittai & Shafer, 2006, p. 433). Adult learners with digital literacy skills gain access to large online libraries and e-books and can engage in discussions with other likeminded individuals through online communities (Bonk, 2010) while exchanging ideas, collecting feedback, and collaborating (Karakas & Manisaligil, 2012) with others around the globe. Many online environments pull in a social component to learning and break away from the historic "isolated" nature of previous SDL episodes (Karakas & Manisaligil, 2012). Adults learning online in these social settings might be alone in their home, yet socially engaged to one or many through a digital chat room, Facebook messenger, or interactive blog.

Karakas & Manisaligil (2012) stated that SDL through virtual worlds allows great freedom for the learner to access vast amounts of information, develop relationships with those far away, and provide elevated levels of inquiry-based learning. These authors also discussed the potential of adults engaged in SDL on the Internet stating these adult learners are “well equipped to be active citizens and informed decision makers in a hyper-connected society” (Karakas & Manisaligil, 2012, p. 718). While this may be the case for some, much research has shown this is not the case for all learners because it does not factor in adult learners with real or perceived digital barriers. These barriers impede the development of digital literacy skills. Research has found "more than a million people in the United States alone are learning online" (Bonk, 2010, p. 62). This informal context of online learning can support and encourage learners to be self-directed because learners take responsibility for their own learning (Garrison, 2003), but the online environment can be a barrier as well.

The Barriers. SDL endeavors through online environments are impacted by many barriers that are real, perceived, or a combination of both (Cross, 1981). Examples of these barriers include an adult learner's lack of time (Cross, 1981), fear of computers (Poynton, 2005), lack of access to online environments (Candy, 1991; Cross, 1981), lack of interest in using computers (Poynton, 2005), inability to monitor their own learning (Song & Hill, 2007), or perceived skills in using technological devices and online environments (Hargittai & Shafer, 2006). Adult learners and their perceptions of online environment and digital resources may create barriers limiting informal learning experiences as "whatever is to be learned will remain unlearnable if we believe that we cannot learn it or if we perceive it as irrelevant or if the learning situation is perceived as threatening" (Knowles, Holton, & Swanson, 2005, p. 88).

Many resources have already migrated to digital formats and many other resources are currently migrating for inclusion in the online resource repository. Librarians are already altering services and programs to meet the digital needs and requests of adult students (Rapchak, Lewis, Motyka, & Balmert, 2015). Publications like, *Science* magazine, a peer-reviewed scientific research magazine published in print since 1980, migrated much of their content online over the last few years. However, editors are hesitant to forsake printed copies of *Science* as only half of those participating in the online subscription option have accessed the online content (Fowler, 2001).

Another barrier from the literature pertains to marginalized adult audiences feeling shut out from employment opportunities due to the migration of once paper-based tests and training to digital formats. Adults now must possess basic digital literacy skills to take advantage of academic or employment advances. For instance, computer-based tests (CBT) now include the Graduate Record Exam (GRE) and Test of English as a Foreign Language (TOEFL). Research on the CBT version of the TOEFL indicate a high correlation between scores and those possessing digital literacy skills and those lacking digital literacy skills (Poynton, 2005). Adults lacking digital literacy skills, perceived or real, might score poorly on important CBTs or avoid taking a CBT altogether.

Research found another barrier as some adults perceive a lack of time (Cross, 1981) to access or learn how to access online resources. The notion of a lack of time, real or perceived, might have these learners avoid accessing the Internet for a learning endeavor. Or, the lack of time might impact the quality of information the learner selects for engagement as research indicated time constraints, real or perceived, cause learners to demonstrate a “snatch and grab philosophy” when they became frustrated with slow search results or search roadblocks (Halverson, Siegel, & Freyermuth, 2010).

In addition to lack of time, others avoid online environments for fear of "not knowing how" to use the computer or to navigate the Internet (Mamary & Charles, 2000, p. 173). Fear of online environments and digital technology can have great social implication on adults and SDL and can create a community based rippled effect (Hargittai & Shafer, 2006). For instance, adults avoid digital learning endeavors then miss out on online community notifications, job opportunities, health information, or civic-minded resources. These adults are essentially shutting out a portion of society simply because they might not know how to use a computer or the Internet.

All barriers, real or perceived, create a *digital divide*, or gap between those adults possessing digital literacy skills and those lacking digital literacy skills. Candy (2004) cautioned practitioners of a digital divide which may cause many learners to be "locked out" of learning experiences (p. 3). Acknowledging the barriers, research has found ways in which these barriers can be dissolved so more adults can benefit from the learning opportunities afforded by digital learning technologies.

Digital tools and technology offer highly interactive and personalized educative experiences for adult learners. Digital literacy skills allow adults to extend the limits of still images and text learning to incorporate dynamic medias enriched with audio and links to more resources (Fowler, 2001). While true for a wide range of content areas, access to dynamic resources through digital tools and literacy has opened doors for learning opportunities. For instance, *Science* magazine found readership has increased significantly over the last few years due to their virtual availability (Fowler, 2001).

Recognizing adults seek and engage in online SDL experiences indicates adults are wanting to learn for various reasons and supports the notion of knowledge becoming outdated. Knowles (1980) stated that "knowledge gained at any point of time is largely obsolete within a matter of years, and skills that made people productive in their twenties becomes out-of-date in their thirties" (p. 41). A sentiment is echoed twenty years later by Berry (2001) when he discussed the importance of one keeping their technology skills up to date as one's computer skills become obsolete quicker than any other human skill.

As adults initiate learning endeavors on digital devices and hone their digital literacy skills, another literacy comes in to play for those adults initiating science-based learning endeavors, science literacy. Adults accessing online environments to learn more on science or scientific processes, must already know something about their search topic as the adult learner is responsible for monitoring their learning and their comprehension (Song & Hill, 2007). Since learners must evaluate their understanding on the science topic at the center of their SDL episode, problems arise when these adults do not have the understanding or expertise to facilitate their learning (Song & Hill, 2007). As adults undertake online learning in science-based areas, they must possess some level of science literacy to facilitate their learning.

Science Literacy

The Internet is used regularly by adults wanting to make sense of new scientific processes (Takahashi & Tandoc, 2015) or search for science-based information (Segev & Baram-Tsabari, 2012). As adults search for information on the Internet, they navigate through millions of web pages negotiating scientific claims and these adult learners must determine if the information is credible (Rieh & Danielson, 2007). Research indicated the Internet has increased the need for adults to possess a functional level of science education or be skilled in science literacy (Britt, Richter, & Rouet, 2014; Charmaz, 2014).

Science literacy is one's ability "to read about, comprehend, and express an opinion on scientific matters" (Miller, 1983, p. 30). Science literacy involves one's ability to understand the role of science and the scientific processes (Falk & Needham, 2013). Some researchers even state that science literacy is synonymous with the notion of a public understanding of science (DeBoer, 2000). This scientific understanding can play a significant role in one's personal health, financial decisions, familial safety, or civic duties. However, recent research indicated a lack of science knowledge despite adults being called upon to make sense of scientific processes which often involve navigating conflicting scientific arguments (Takahashi & Tandoc, 2015).

Goals of Science Literacy

One of the fundamental goals of science literacy as noted in the literature is for learners to have the skills and scientific knowledge to search for information regarding new science-based concepts especially those linked to current events (Segev & Baram-Tsabari, 2012). Cooper and Farid (2016) support this definition as they suggest scientific literacy as being one's ability to "read and understand scientific findings as reported by the media" (p. 147). Science literacy does not end at the ability of one to read and understand the content, adults must be able to do so in a critical manner. Britt et al. (2014) emphasized that science literacy requires one to "critically evaluate scientific content" (p. 104). Miller (1983) urged a fostering of knowledge and participation in the sciences in efforts to improve public discourse especially in the realm of policy and civic duties. As of 2015, research reported scientific literacy rates in the United States remain "relatively low" (Takahashi & Tandoc).

Importance of Science Literacy Skills

Possessing science literacy skills is not an option for adult learners, these skills have become a necessity in today's learning climate. Research has indicated the information seeking behaviors of adults are directly related to their scientific knowledge and their critical approach to evaluating the information (Takahashi & Tandoc, 2015) encountered during their online learning episode. Problems arise when trying to gauge one's science literacy as there is "no body of knowledge that can legitimately define it" (DeBoer, 2000).

Like SDL, science literacy is not a new concept. Its importance to education and society has been mentioned in literature for the past forty years. In 1975, Shen stated that "today, science affects almost every aspect of our lives, and we can expect its dominance to be even greater in the future" (p. 265). Shen (1975) went further to discuss the importance of understanding science and scientific processes relating to public issues as those will "only increase in number and importance in the future" (p. 267). His comments are still applicable to science's role in society and the various components of our personal lives. Miller (2010) stated that "adults function as consumers, parents, patients, and citizens, and they will need increasingly higher levels of scientific understanding to make personal and political choices" (p. 191). Adults weak in or lacking science literacy skills, might have difficulties discerning credible science-based information from non-credible science information on the Internet which can negatively impact their lives.

Research has also indicated the lack of science literacy skills can also impact one's learning motivation. Scientifically literate adults reportedly have a higher learning motivation, especially when conflicting science information is involved. The conflict causes dissonance for the learner which reportedly causes motivation to find resolve. For those without science literacy skills, they tend to not seek resolve. Rather when faced with conflicting information, those lacking science literacy skills typically leave the scientific learning endeavor out of confusion from being scientific illiterate (Shen, 1975).

The dynamic nature of science can prove problematic to those lacking or deficient in science literacy skills as scientific facts and findings from today might be overturned by new research findings published tomorrow (Miller, 1998). For instance, in 1930, Pluto was named the ninth planet in our solar system. However, in 2006, scientists conducted further investigation into Pluto and the nearby celestial bodies in the Kuiper Belt. They determined Pluto lacked a "gravitational dominance" required to be classified as a planet (http://www.bbc.com/news/science-environment-33462184). This new discovery caused Pluto to be downgraded from a planet to a dwarf planet and the reclassification restructured classroom science textbooks. Children now learn about the eight planets in our solar system rather than nine planets. Science, by nature, is fluid. Research yields new findings and these discoveries can potentially impact what we had previously accepted as fact. Scientifically literate adults understand this to be the nature of science and critically examine the research before blind acceptance.

Types of Science Literacy

Science encapsulates so many disciplines and extends into so many reaches of our lives that scholars researching the concept of science literacy offered various classifications. Shen (1975) posited three types of science literacy: practical, cultural and civic. Practical science literacy was one's ability to understand science necessary to solve everyday questions (Cronin & Messemer, 2013). A current example of practical science literacy is the scientific knowledge needed by a home owner interested in properly insulating their home. The homeowner would need to research proper R-values to ensure they purchase the correct insulation type to weather proof their home.

The second type of science literacy, referred to as cultural science literacy, pertains to one's epistemological approach to science and relates to their overall understanding of science (Shen, 1975). Cultural science literacy is the learning of science for the sake of learning and enjoyment. An example being the earlier vignette presenting Mr. Morgan's learning episode on the tree he had become interested in identifying. He received no grade or benefit beyond personal satisfaction by identifying the tree species in question.

Lastly, civic science literacy pertains to one's ability to comprehend everyday science regarding our democratic political system. Miller (2012) indicated civic science literacy as being the "minimal level" necessary to engage in scientific debates, understand scientific policies in government, and understand basic scientific information in the media. A current example of civic science literacy pertains to one's understanding of climate change. Climate change is a complex scientific process associated with many controversies: human or natural causes, the various ways to reduce impact, the argument of who is to be impacted, etc. This highly controversial topic is at the center of global debates and has been a part of the national political platform for the past three Presidential elections. Science literacy is an integral part of a functioning society, but research is conflicting on the current state of adults who can be classified as scientifically literate.

Current Science Literacy Projections

Research has been conducted to determine science literacy rates of adults. Miller (2012) collected data on science literacy levels, specifically civic science literacy, in the United States for thirty years and found almost half of the adults questioned could be classified as scientifically literate. On the contrary, Cronin and Messemer (2013) stated that 25% of adults in America are scientifically literate citing “America’s adult populace has failed to keep pace with the rapid inundation of science-centric knowledge” (p. 143). Research published one year apart, indicates a large discrepancy in adult science literacy rates. In my opinion, this discrepancy highlights the broad reaches of science and the difficulties in assessing a national science literacy rate for adults.

Science literacy skills are reported to be instilled during formal school years as student attitudes are formed towards science and towards learning (DeBoer, 2000). Research showed further development of science literacy skills in those who had enrolled in college science courses (Miller, 2012). This research was further explored by Dimock, Doherty, and Keeter (2013) as they found “people with at least some exposure to college” perform better in the areas of science. Research could not be found on if the college science course increased scientific literacy because of extended lessons in science or because of the individuals overall interest in science. However, research has found online science-based information written to reach a wide range of reading skills and learning styles assists learners going forward (Britt et al., 2014).

Learning about science online has many challenges; for example, sorting through the abundance of resources, discerning quality of information, realizing oversimplified information, and accessing credible science information. "It is becoming increasingly important to understand what contributes to scientific learning, including information sources and trust in those sources" (Takahashi & Tandoc, 2015, p. 1). The amount of information can be overwhelming, and information can be questionable, partially inaccurate, or completely inaccurate. Research has reported approximately 75% of resources found online were considered unreferenced (Britt et al., 2014). Through these challenges, adults, specifically non-science experts, are now responsible for determining which science resource is credible, which authors are experts. Adults must develop coping strategies to settle dissonance created from encountering conflicting information (Britt et al., 2014). Research acknowledged hurdles faced in determining credibility of science-based information are like those faced by anyone learning a new subject area (Britt et al., 2014). However, these authors recognized a difference in the learning interface of science and technology as adults experience a sudden shift in context and content while navigating a large abundance of resources (Britt et al., 2014). The ways in which adult critically evaluate scientific resources can be directly linked to their level of information literacy.

Information Literacy

Information literacy is important to adults who access and engage with SDL through online environments, as these adults must learn to make judgments on information quality (Song & Hill, 2007) as well as synthesize content, and decide the direction in which to continue their search (Association of Colleges and Research Libraries, 2000). Research has gone as far as stating “information literacy forms the basis for lifelong learning” (Association of Colleges and Research Libraries, 2000, p.2) as information literacy “includes the ability to ethically and effectively find, access, evaluate, and use information" (Rapchak et al., 2015). Information literacy skills allow learners to determine the type and quantity of resources needed while effectively and efficiently assessing the information they encounter in a critically manner (Association of Colleges and Research Libraries, 2000).

The Internet contains a wide range of scientific resources from credible to intentionally misleading (Britt et al., 2014). Research has identified the need for learners to possess critical evaluation skills to determine the quality of information (Candy, 2004; Irving & English, 2011; Karakas & Manisaligil, 2012; Song & Hill, 2007), the ability to discern between information and misinformation (Calvert, 2001; Karakas & Manisaligil, 2012; Metzger, 2007), and the awareness that online resources are made available to intentionally mislead learners, (Mo Jang & Kim, 2018). Being mindful of critically evaluate online resources is important especially in the scientific fields as so many are tainted in controversy.

Access to the Internet opens the door to vast amounts of scientific information, yet "it has also removed or at least enables a bypass of traditional filters and interpreters and exposed lay readers to both the full complexity of scientific discourse and a host of fraudulent claims" (Britt et al., 2014). This is a concern as website and resource evaluation becomes the responsibility of the learner (Halverson et al., 2010). Additional problems arise when the learner does not understand the science content adequately enough to judge resources and find answers to their questions (Halverson et al., 2010).

Online scientific information is uploaded by essentially two groups: the scientists who have conducted the work or the staff tasked with reporting out the findings for broader impacts (Takahashi & Tandoc, 2015). Prior experiences with both groups has led me to conclude they both struggle with effective communication. Scientists struggle with discussing their highly specialized research with non-science experts. Likewise, inexperienced staff mistakenly shorten reports omitting important science facts thus causing confusion or misinterpretation on the reader's part. Online science resource must be packaged in a manner to reach the target audience and be short enough to contain accurate information, yet not so long the learners quit reading (Fowler, 2001).

The Internet is full of misinformation which causes persistent problems (Piper, 2000). Misinformation can be spread through counterfeit and malicious websites, but also through humorous spoof websites (Piper, 2000). Online learners must not only navigate an enormous amount of information, but also navigate intentions of the website's sponsors since anyone can write and publish information on the Internet (Johnson & Kaye, 2002) as there is no "universal standard" for the information being posted (Metzger, 2007, p. 2078). With countless of authorless webpages available (Warnick, 2004), an adult learner can become ignorantly misinformed, frustrated from lack of information, or confused by conflicting information. Adults who access and engage with the Internet must now learn to make judgments on information quality. Adults have established a way in which they make these judgements and self-reported data suggested some adult learners look at the date of last revision or the source of information (Song & Hill, 2007). Other research indicated the adults base their decisions off prior individual experiences or hearsay derived from the experiences of others (Wilson, 1983).

Certainly, there are other ways in which adults evaluate information quality as they sort through what research has estimated to be around seven billion documents (Triese, Walsh-Childers, Weigold, & Friedman, 2003). Adult learners must decipher fact from fiction and discern credibility of the resources with which they engage. Calvert (2001) and Piper (2000) stated that the Internet contains a wealth of misinformation whether made available intentionally or accidentally. Through evaluating the credibility of online information, adults can critically accept or deny assimilation of information. However, defining credible information has not proven to be an easy task.

Defining Credible Information

Before evaluating credibility of resources encountered online, an adult must have an operative definition of the term *credibility.* Research indicated that credibility is extremely difficult to define and remains yet to be clearly defined (Rieh, 2002). The meaning is uniquely crafted by each learner based on an array of personal and secondary experiences. According to the literature, the lack of definition is due to *credibility* being a "complex and multifaceted" construct (Wathen & Burkell, 2002, p. 140) and the individualistic nature of the construct creates a multi-dimensional concept which has been incredibly difficult to generalize into a definition (Mason, Boldrin, & Ariasi, 2010).

Literature is available from several studies that have researched ways in which credibility has come to be defined. For instance, research has defined credibility through other constructs (Tseng & Fogg, 1999; Metzger, 2007; Hilligoss & Rieh, 2008), through a relation to the information source (Wilson, 1983; Rieh, 2002), through positive and negative advertisement links (Greer, 2009), and through domain preference (Triese et al., 2003). While no common definition for credibility resulted from the above-mentioned research studies, the added literature further supports the difficulty of defining credibility.

Moving from defining the construct of credibility, library studies research was conducted on information evaluation strategies to help online learners find credible information (Smith, 1997). This approach focused on equipping the learner with skills to discern credibility rather than focusing on how to present online information. The shift from determining how information is perceived as credible has shifted to teaching the learner how to identify credible information.

Another attempt to define credibility, led researchers from the resource creation perspective to sub-divide the construct into types of credibility. These researchers, Tseng and Fogg (1999), defined credibility by classifying the construct into four types of credibility: 1) presumed credibility, 2) reputed credibility, 3) surface credibility, and 4) experienced credibility. *Presumed credibility* is based on the learner's assumptions. For instance, assuming one's spouse tells the truth makes that spouse credible. *Reputed credibility* is based on what one seems to think more credible. For instance, medical advice from one's primary care physician would be more credible than advice garnered from the grocery store cashier. *Surface credibility* pertained to superficial characteristics or looks, much like the old cliché about judging books by their covers. This type of credibility assessment is almost automatic in today's fast past decision-making. The final category is *experienced credibility* which pertained to decisions made based on one's experiences. This fourth category is the most unique, and therefore the most complex of the types of credibility.

While other ways to define credibility from the learner's perspective or the resource perspective exist, the bottom line is that no definition has come to fruition and more research is needed. Adults continue to assign credibility to information they encounter online, and research is needed to determine how they assess credible information across disciplines. Information credibility and credibility assessment criteria are a multi-discipline concern and researchers in the fields of computer technology, accounting, communication, and media studies (Fear & Donaldson, 2012) continue to work on defining credibility and determine how credibility of online resources are assessed.

Assessing Credibility

Research on ways in which adults make judgments and assess credibility showed learners are leerier of online information due to the lack of a "control mechanism" (Rieh, 2002, p. 156) while other research has shown adults perceive the Internet as a credible source (Johnson & Kaye, 2002). Further research on credibility has been conducted that investigated a possible relationship of source credibility to advertising credibility (Greer, 2009), credibility in relation to certain domains (Triese et al., 2003), and whether credibility or convenience was preferred by learners (Metzger, Flanagin, & Zwarum, 2003). Each study peeled more layers of the proverbial onion and each study provided a springboard for the present study.

Research studies have attempted to classify credible evaluation variables and develop a set list of criteria their participants used to evaluate the information. However, these studies found a differing number of criteria used to evaluate online information; for instance, Tseng and Fogg (1999) found credibility could be defined as *believability, trustworthiness* and *expertise*. Metzger (2007) derived five criteria (*accuracy, authority, objectivity, coverage,* and *currency*). Smith (1997) estimated six criteria (*scope, content, graphic design, purpose, reviews,* and *workability*), and the final study by Triese et al. (2003) found two criteria (*trustworthiness* and *expertise*) comprised the larger construct of "credibility." For instance, credibility of online science information is operationally defined differently than credibility of online travel information. Due to subject matter differences noted in the literature, the following section discusses research studies which investigated how learners navigate digital media and science resources based on credibility decisions. Vast quantities of research exist, but the selected studies were included because of the similarities to the present study.

Relational credibility. Several research studies discussed credibility being impacted by other people or prior learning experiences. Rieh (2002) stated that cognitive authority referred to the trustworthiness of information. This concept, introduced by Wilson (1983), allowed the learner to identify credible information which is believable due to first hand experiences or second-hand knowledge from family or friends. Cognitive authority is relational and is created in one person's perspective, yet exists in a perpetual state of motion, constantly evolving as new experiences and information is processed (Wilson, 1983).

Assigning cognitive authority is a multi- faceted task as it requires many aspects to be weighed by the learner during the decision process. The concept of cognitive authority from prior knowledge and this relationship between people and experience begins to touch on the social nature of online learning and how learners assess information as credible (Tseng & Fogg, 1999). Metzger et al., (2003) discuss experiences and social input as major influences on validating credibility decisions of online learners.

Another research on relational credibility, was conducted by Rieh (2002). During this study, she engaged sixteen Rutgers scholars in four web-based search tasks lasting fifteen minutes each followed by semi structured interviews geared at discussing their web-based searches. The web-based search and interview portions were audio and recorded and the scholarly participants were asked to keep logs of their web page visits during the online portion. These online tasks pertained to general topical searches which would typically be conducted online by the general adult populace on an average basis with one task focused on each of the following: travel, medicine, research, and shopping. Through coding participants' responses, Rieh (2002) found predictive and evaluative judgments were at work when participants conducted web searches and participants typically trusted like-minded sources or "scholarly" looking sources (p. 156). Locating scholarly articles is typically an easy task for fellow scholars, but adults not accustomed to this type of academic searches and terminology may lack critical skills necessary for locating and evaluating information credibility.

In a 2008, Hilligoss and Rieh presented the Unifying Framework of Credibility Assessment Model, see Figure 1, which depicted three influences (*construct, heuristics*, and *interaction*) formulated by one's definition of credibility. These influences, depicted as layers in the model, are situated under a contextual umbrella signifying the learning context which influences the entire learning process. The learning process experiential and iterative much like the concept of a learning transaction as discussed by Dewey (1938). Research indicated the context is important in one's learning experience and has a significant impact on one's credibility judgment (Rieh, Kim, Yang, & St Jean, 2010).

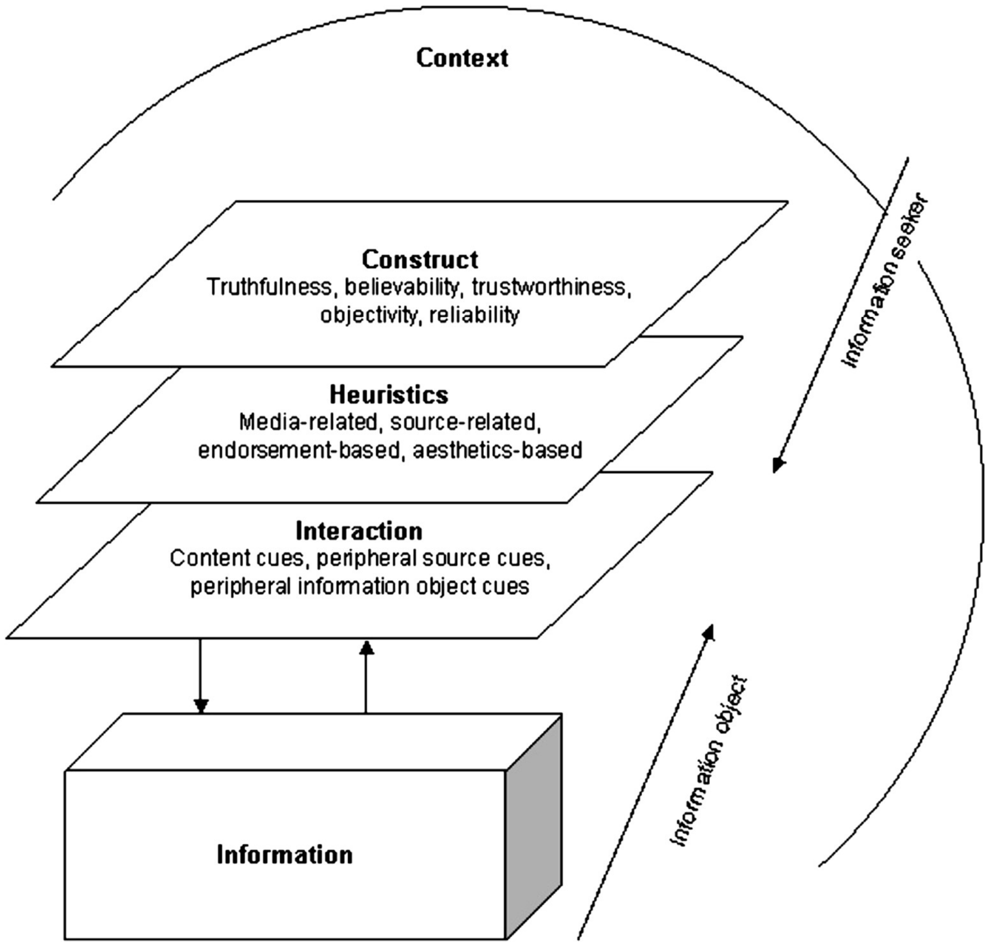

Figure 1. Unifying Framework of Credibility Assessment (Hilligoss & Rieh, 2008). Model reprinted here with permission of authors.

When engaged in Internet-based learning, adult learners have pre-established criteria or constructs defining credible information. In the model, the *construct* level represents the leaner's personal definition of credibility and points of view which impact their considerations for evaluating information as credible or non-credible (Hilligoss & Rieh, 2008). In addition to credibility lacking definition, research indicated the multiple definitions of credibility can be held by an individual (Rieh, 2002); for instance, one might define credibility or a lawyer advertisement as trustworthy and define credibility of a new fad diet as believability.

The next level, the *heuristic* level pertains to general rules the learners use when making judgments on credible information. Credibility decisions at this level are quickly made and are influenced by locating information conveniently rather than being influenced by content expertise or information accuracy (Hilligoss & Rieh, 2008). Resources not quickly judged can potentially cause learners to leave and search other sources (Wathen & Burkell, 2002). Hilligoss and Rieh (2008) divided this level into four categories based on the type of media (*media-related*), the origins of the information (*source-related*), sponsorship or reputation (*endorsement-related*), and how the resource looks (*aesthetics-related*). Examples of heuristics in evaluating online information include an adult searching for information on familiar sources while avoiding unfamiliar sources or an adult being drawn towards professional, well designed webpages.

The third level in the Hilligoss and Rieh's (2008) model is the *interaction* level. This level is the narrowest layer of the framework a focused on specific resources. This layer operationalizes the adult's general rules as the interaction level pertains to information with which the learner has selected for engagement. When the learner is engaged with this level, the learner is evaluating specific components of the resource such as the content, the source, or the sponsorship to determine if the resource is credible or noncredible. To make decisions, the learner evaluates the resources through the lenses they bring to the learning table. Much like Wilson's (1983) research on cognitive authority, decisions guiding information interaction stem from the personal experience of the learner (labeled by Wilson as "first-hand experience") and/or the experience of others which have been relayed to the learner (labeled by Wilson as "second-hand knowledge").

The last and bottommost level of the Hilligoss and Rieh's (2008) model, is a large box representing the vast amount of *information* the learner accessed, engaged with, evaluated, synthesized, or avoided during their learning experience. Operationalizing the framework for this study, the *information* box represented the science-based resources encountered by the participant, or *information seeker*, during their online session. The *information object* pertained to the information the learner has garnered from the search. *Information objects* represented the learning resources the learner encountered which caused the learner to reflect on their definition of credibility and adjust accordingly for future information searches.

Perceived credibility. Other research conducted by Greer (2009) approached online information credibility through a journalism lens with the goal to investigate connections between source credibility and advertisement credibility. The source-ad pairings included combinations of a source and ad from the following category: highly credible sources (for example, New York Times), highly credible ads (for example, Neiman Marcus), low credible source (for example, personal mock webpage), and low credible ads (for example, psychic readings).

Greer's (2009) findings stated that highly credible sources with longstanding good reputations are more often deemed as credible sources, and there was a slight negative impact when the highly credible sources were placed alongside a low credible advertisement. However, Greer (2009) noted that online advertisements are largely ignored as only 1.7% of participants paid attention to the web ads and 45.5% of the participants reported they did not notice the advertisement at all. As for significant findings, Greer (2009) found most participants reported weighing the source credibility greater due to source cues rather than advertising cues.

Credibility Concerns Across Disciplines

Information credibility and credibility assessment criteria are a multi-discipline concern. Researchers in several fields including computer technology, accounting, communication, and media studies (Fear & Donaldson, 2012; Lim & Simon, 2011; Lederman, Fan, Smith, & Chang, 2014; Irving & English, 2011) have offered attempts to define credibility and determine how credibility is assessed in their fields. Others, like Wathen and Burkell (2002), tried a hypothetical approach to investigate credibility criteria. The following section provides more details on these studies and their findings.

Fear and Donaldson (2012) found their study's participants relied on firsthand experiences when determining credibility of research in a dataset. The researchers agreed there were "disciplinary norms" of firsthand experiences of cultural pressures impact science credibility and one's definition of credibility. Lim and Simon (2011) stated that the definition of credibility varied "from researcher to researcher" (p.2). In their credibility research, they discussed the notion of bounded rationality which means the learner has a finite knowledge that is impacted decisions in their learning endeavor. Due to this, learners must make decisions on how they sort the information and evaluate it as credible. Lim and Simon (2011) also indicated learners are looking for information to suffice the current learning situation rather than finding the most accurate information. Obviously factoring in how learners go about critically evaluating the information they encountered during learning episodes.

Lederman et al.'s (2014) research on online public health forums indicated the learners select convenient information and anonymous resources. Through their qualitative approach, they identify four types of credibility discussed in the literature: information credibility, source credibility, media credibility, and web credibility. Irving and English (2011) identified credibility as a major issue in their research on woman's organizations and nonprofit advocacy groups. They defined credibility in terms of trustworthy, current, accurate, open, honest and reliable, but the "overall impression of credibility, admittedly, is a subjective measure" (p. 272).

Wathen and Burkell's (2002) proposed a hypothetical search based on a literature review which determined the interaction with superficial aspects of a website would cause a learner to continue or move away from the resource. Again, their findings stated credibility is unique to each learner and determining credibility is an iterative process of searching for information on the Internet. This idea of an iterative process was supported later in Warnick's (2004) publication when she stated the need to address this issue of credible online information and the need to recognize the fluid "circularity" movements of online users regarding source identification and sponsorship cues.

Information literacy and information credibility concerns stemmed from education fields into consumer industry. Fogg, Soohoo, Danielson, Marable, Stanford, Tauber (2003) sampled 2,684 participants to evaluate website credibility based on the web features noticed by Internet consumers. Of the consumers, over 46% took credibility cues from the web page design, 14.3% took credibility from information accuracy, and 13.8% took credibility cues from advertising. Even with a large sample size of predominantly female participants (58.1%) averaging 39.9 years in age, spending 19.6

hours per week on the Internet, and ranging from the thirty countries, including the United States, these authors claimed that much research is still needed. They stated the work on determining web credibility is still “far from complete” (Fogg et al., 2003, p.2).

Stepping back from credible content, research was conducted on credibility perceptions of web addresses or domains of online resources. Triese et al. (2003) conducted a two-part study examining domain credibility of .gov and .com domains regarding science information. The authors used a paper-based questionnaire tool to collect data from all participants asking each to gauge their perception of domain credibility. Additionally, the authors evaluated participants’ science background or science class history, comfort and frequency of web use, and perceived science content knowledge. Many of these participants engaged in a secondary computer-based activity to capture their actual web behavior in searching for specified science information.

In their findings, a nine-point bipolar response pertaining to the participants’ science history and background, perceived web use, and motivations for seeking information was analyzed through factor analysis and concluded the participants felt .gov sites were more credible than .com sites. While this study’s credibility criteria focused around trustworthiness and expertise, the authors added a caveat that “relatively little research to date” has been conducted to demonstrate “that in fact people do use these criteria in evaluating online information or source credibility” therefore admitting that “the term credibility is slippery indeed” (p. 312). Lastly, the authors encouraged future research to be conducted on “usefulness” of a science-based website would possibly prove more salient criteria than “credibility” or “accuracy” (p. 330).

Another study focused on credibility being garnered from attributes other than printed text. Metzger, Flanagin, and Medders' (2010) investigated pre-established search strategies the learners possess and ways in which the strategies are activated when embarking in an online learning endeavor. Metzger et al. (2010) evaluated the concept of credibility evaluation based on heuristics. The research stated the users have developed shortcuts or general operating rules of the mind that reduce time invested and cognitive load when tasked with making decisions. Although this research is based on self-reported data collected in focus groups, findings suggest five common heuristics based on the reputation of the source, conferred or recommended sources, consistency in message across resources, expectations of resource, and presence and type of commercial content.

Content Specific Credibility: Credible Science Information

Research has examined participants learning online in a formal science classroom setting or supplied self-reported data not real-time date. The first study by Halverson et al. (2010) evaluated college students' criteria of credible science information found during internet searches on stem cells. Approximately 75% of the participants thought "perceived credibility of the resource" was important with accuracy and completeness ranking second (67%). Other criteria that surfaced were: content (95%), aesthetics (26%), readability (27%), references to other stem-cell sites (31%), and the nature of how the information was presented (56%). Findings add to the literature gap on evaluating online scientific information, specifically a controversial topic that is considered a "socioscience issue" (p. 613). This study captured actual use patterns of the students and credibility criteria.

An earlier study by Wiley et al. (2009) discussed the tasks of online learning from multiple texts with a focus on users processing and comprehension capabilities. Wiley et al. (2009) found the students garnered factual and accurate information from online science inquiries. While this is the case, some of the information relayed by the online learners was erroneous. The authors thought this might be linked to search behavior and noted the future research should focus on the behavior of how long participants spend on selected sites and the number of times participants revisited pages. Additionally, Wiley et al. (2009) captured web patterns and website visited by undergraduate students during their study on source evaluation and learning science on the internet. During observed computer queries, the authors noted the participants' site visits, length of visit, pauses, and site revisits. The participants' behavior was documented through several methods: Dual-Purkinje head mounted eye trackers, think alouds, and combined head mounted eye trackers with think alouds. Once the computer tasks were complete, participants wrote essays pertaining to their online search topic. These essays were peer reviewed and judged by others that had also conducted the search to determine "quality of information" and testing the students' ability to apply new science knowledge (Wiley et al., 2009, p. 1075).

Mason et al. (2010) conducted research on middle school children's evaluation of controversial scientific information on the Internet. They stated that finding factual science information stems from "formulating efficient search queries and applying appropriate reading strategies" in addition to evaluating the resources (p. 68). Findings indicated the information evaluation required learners to be critical thinkers who reflect on their current scientific knowledge and ways in which new information interacts with current epistemologies.

Literature Impacting Credibility Assessment Research Methods

In addition to the literature guiding the content of the study, many facets of the methods presented in the next chapter, Chapter Three, have been influenced by the literature review. These influences range from the participant selection methodologies and stimulated recall interview protocol. Selected participants had an interest in science due to literature indicating the importance of motivation to learn from a self-perceived knowledge gap (Segev & Baram-Tsabari, 2012) and the importance of participants to be interested in their search topics (Quinney, Smith, & Galbraith, 2010, p.208). Participants had experience learning science information online in a self-initiated autonomous manner. This criterion was important as to best capture individuals with capacity to learn in a self-directed manner as Song and Hill (2007) stated literature does "not have an adequate understanding of the impact of a specific learning context on self-direction". Lastly, participants were of similar ages to best align digital competency and literacy skills since research has shown the differences in age yield differences in online learning approaches (Quinney et al., 2010).

Computer tasks were influenced by the literature regarding task content and decision markers. In a study conducted by Dimock et al. in 2013, approximately half of the adult populace reportedly knew about climate change and "fracking." Given the saliency and controversial nature of climate change and fracking in today's news, these topics were selected as the focus for the computer search session. Selecting controversial topics increased probability of the participants encountering a mixture of resource types and sources. Additionally, these terms increased the probability of search results being populated with opposing views, varied levels of scientific jargon, and variation in sources of information and misinformation. These recorded computer searches captured actual search strategies rather than perceived or self-reported search strategies which was identified as a need in the literature by Hargittai and Shafer (2006).

Data generation strategies were influenced by literature as Rieh's (2002) study utilized concurrent and retrospective think aloud protocols to best capture the participants' thoughts regarding her subject matter. In Rieh's (2002) discussion of her research, she encouraged future research to apply her findings and methodological protocols to different participant groups, such as those not situated in academics or scholarly pursuits. Additionally, data generation was influenced by Butefish's (1990) observation and video narrative methods.

Due to methodological literature reviewed, I opted to use a retrospective think aloud protocol known as a stimulated recall interview (Butefish, 1990). Research on concurrent think aloud protocols indicated concurrent think aloud strategies can negatively impact the task participants are to perform as participants would focus on putting actions in words rather than conducting the actions since talking through thoughts is not a typical normative behavior. Rieh (2002) also stated that asking participants to put words to their actions as they are simultaneously doing a task can cause them to forget what they were in the process of doing. Additionally, Hilligoss and Rieh (2008) led me away from concurrent think aloud strategies as they stated credibility decisions being made internally thus making it difficult for participants to discuss their thinking.

Lastly, the methodological framework for this study stemmed from a study on credibility conducted by Hilligoss & Rieh (2008). For my research purposes, Hilligoss and Rieh's (2008) Unifying Framework of Credibility Assessment, shown in Figure 1, supported the constructivist approach that undergirded this study. Both, constructivism and Hilligoss and Rieh's (2008) framework, acknowledged the uniqueness of each participants' personalized definition of credibility and credible science information.

Relevance of Literature for Present Study

In 1961, Houle stated that "the next 20 years might see the development of new ways of learning new things" (p. 43). Almost twenty years later, Tough (1979) repeated Houle's sentiment and included a reference computers integration into learning. Tough predicted that "as computers become less expensive and easier to use, they may play an increased role in helping learners find appropriate resources (p. 124). Both sentiments have come to fruition. Currently, self-directed learners are conducting learning episodes on tablets, smart phones, and laptop sitting out on the beach or in a coffee shop. However, it seems little to no literature is available on how these learners are navigating these devices and the millions of resources to learn science.

Miller (1998) stated that it is important to have more research on resources used by adults in learning science. In today's digital age, adults engaging in online science-based SDL endeavors potentially have access to an unlimited virtual network of information and resources irrelevant of the topic of interest (Candy, 2004). While much research has been conducted on the espoused criteria used to evaluate credible online information, little to no research was found pertaining to real-time search data on credible science-based information.

Current research indicates the learners are using minimal verification to check credibility of online resources (Metzger et al., 2003). Reviewing the literature has presented knowledge gaps in determining how adults interact with science resources presented in an online context specifically, how adults make real-time decisions, how adults define credible information, and how adults evaluate online science-based information. Candy (2004) stated that "self-directed learning is a vital aspect of the digital revolution" (p. 3) and that "some evidence suggests" that some more recent technological advances meet the needs of self-directed learners (p. 4) yet, research indicated unskilled search behaviors can have negative impacts when interacting on the World Wide Web (Meyers, 2010).

As Mocker and Spear (1982) stated almost forty years ago, more research is needed on the interactive space between researchers as there is a gap of studies focusing on "how human and nonhuman resources affect the process; what happens when learners cannot get the help they need, and what kind of help would most benefit these learners" (p. 14). More recent researchers have also identified a similar gap. Irving & English (2011) stated the need for a greater understanding of how the Internet is "used, understood, and controlled" (p. 266). Greenhow et al. (2015) reiterated that, while research has shown learning occurs through informal interactions, little research has been conducted on informal learning within an "out-of-school online context" (p. 593). The need for additional research on self-directed online learning habits is apparent along with the need for research on the human-Internet learning interface.

Lastly, literature gaps on science literacy and information literacy guided the present study. Earlier research was conducted on gauging credibility of Internet based information, yet the research focused on different content areas, professional groups of adult learners, and formal learning situations. No research was found to date that focused on the actual webpage and criteria assigned by a self-directed adult during an Internet-based learning episode. Irving and English (2011) recognized the enormous amount of informal learning that is occurring online and urge future research to be conducted to target specific content searches conducted by adults.

Takahashi and Tandoc (2015) suggested several additional literature gaps in which this study can be situated. The first gap was identified when they stated a "need to further explore the relation between media consumption and scientific knowledge by examining possible mediators such as trust in the sources of information" (p. 5). These authors also indicated a recent need for more research on how adults searched for scientific information since traditional sources of science-based materials are being replaced by digital sources (Takahashi & Tandoc, 2015). An adult populace with science literacy skills has become a salient issue considering the recent media increased in "fake news" accusations (Mo Jang & Kim, 2018) and removal of governmental pages intended to provide national and regional science-based resources (Environmental Protection Agency and United States Department of Agriculture to be specific).

Segev and Baram-Tsabari (2012) indicated adults in Western countries, like the United States, are turning to the Internet as their sole source for science-based information, yet research has seemingly forsaken this group and focused on formal online science-based learning. Today, anyone with access to the Internet, a networked digital device, "and the appropriate skills" can access large volumes of information (Rager, 2003, p. 18), but importance lies in understanding how these individuals are accessing this information. Skills such as digital literacy, science literacy, and information literacy are necessary for these adults to acquire a level of independence in learning. Adults possessing this type of independence have the “ability to think critically and solve the everyday problems of life" (Howard, McGee, Shia, & Hong, 2001, p. 1). The present study adds to the literature pertaining to credible science-based information and ways in which adults conduct online searches. The following chapters discuss methodologies used to explore the research questions during a real-time search in which adults accessed online science resources and websites.

CHAPTER 3

METHODOLOGY

The purpose of this study was to examine the ways in which adults, specifically non-science experts, identified credible online science-based information during real-time Internet searches. The study specifically examined the interface of science literacy, digital literacy, and information literacy as participants are asked to identify credible science-based information through real-time Internet searches. Research was guided by the following questions:

1. How do non-science experts define *credible science information*?
2. What general rules and cues do participants use to select credible science-based websites during an online search?
3. How do participants evaluate credible controversial science-based resources found online?

This study garnered valuable real-time data collected as adults explored online science-based resources and provided evidence on how they evaluated credible scientific information. This chapter begins with a discussion of the conceptual framework focusing first on the general notion of credibility then moving to a more specific discussion of credibility of science information in an online context. I next discuss the research design including the processes used for generating and analyzing data generated from the study.

Conceptual and Methodological Framework

This study utilized methods intended to provide a glimpse into the cognitive processes of adults as they evaluated science-based information encountered on the Internet during a real-time online learning episode. The research is guided by a constructivism philosophy in that making meaning stems from a learner's collection of experiences. Piaget and Dewey asserted meaning is constructed through experiential learning opportunities. Meanings and knowledge the self-directed learners hold as truth can change instantly as new knowledge uncovered during these learning experiences impacts current epistemologies (Raskin, 2002). This iterative learning process has adults reformulating and transforming meanings as the learning episode progresses. Research indicates learning is not isolated, and meanings are influenced by experiences and society (Papert & Harel, 1991). By applying a constructivist approach to adult learning, the complexity and uniqueness of learning episodes and their individual collection of experiences are acknowledged. Berland, Baker, and Blikstein (2014) indicated an application of a constructivist philosophy is essential in promoting a "deep understanding of relatively complex content" (p. 207) such as science and technology.

From guiding philosophy to conceptual framework, the present study was framed around components of Hilligoss and Rieh's (2008) Unifying Framework of Credibility Assessment (see Figure 1) which was discussed in detail in Chapter Two. As discussed previously, Hilligoss and Rieh's (2008) framework was selected because it encompassed a constructivist philosophy of learning, embracing the uniqueness of adults in their learning experiences; thus, embracing participants' individualistic evaluation strategies and personalized definitions of "credibility." When interpreting the model, the authors state the credibility assessment is unidirectional moving from broadest construct level to narrowest interaction level (Hilligoss & Rieh, 2008) which is representative of active constructivist learning where learners are constantly reformulating and amending currently held definitions and making rapid decisions which ultimately impacts the next iteration of learning.

The Hilligoss and Rieh's (2008) framework is much larger than the scope of this research project, so this study has pulled the pertinent components from the framework. These selected components include: a specific learning context (informal learning), the *construct* of credibility, *heuristics* regarding online resources, and *interactions* regarding online resources with a study specific layer due to the specificity in information (climate change and fracking). By applying these layers of Hilligoss and Rieh's (2008) framework I can best capture participants' constructs of *credibility* while identifying criteria used to classify science information as credible during a real-time information search on the Internet. The following section discusses the selected components of the Hilligoss and Rieh's (2008) framework in relation to the guiding research questions.

Applied Layers of the Unifying Framework of Credibility Assessment Model

Hilligoss and Rieh (2008) noted many ways in which scholars have attempted to define credibility, indicating credibility is incredibly subjective and capable of being defined by other concepts such as believability or accuracy. These authors indicated the possibility of defining credible information by domains or credibility decisions being linked to other judgments like information quality. For the purpose of this study, credibility is defined as a function of scientific information and is based on Fogg et al.'s (2003) definition in which credible information is considered to be trustworthy information lacking biases. Given the nature of science and the controversial scientific topics apart of society, I felt this definition was most appropriate as it best captured what I see as society's perception of these controversial processes.

Table 1 indicates the layers of this present study, identifying which layers were adapted from the Unifying Framework of Credibility Assessment model (Hilligoss & Rieh, 2008). The layers are displayed next to the corresponding research question used to explore the layer in this research study. Other components of the model, context and information, are defined as the online learning context, or the Internet, and science-based resources engaged with while accessing the Internet.

Table 1. Adapted Hilligoss & Rieh (2008) Layer and Corresponding Research Question.

Layer	Research Question
Construct	RQ #1: How do non-science experts define credible science information?
Heuristic & Interaction	RQ #2: What general rules and cues do participants use to select credible science-based information during online searches?
Study Specific	RQ #3: How do participants evaluate credible controversial science-based resources found online?

Initial layer: Construct of credibility. This layer focused on evaluating the participants' perception of credibility. Given the complexity of defining credibility, this research bounded constructs via a specific content area: science. Evaluating the participants' construct of credibility in this content area aimed to identify how non-science experts defined *credible science information* (Research Question One).

Middle layer: Heuristics and Interaction. In Hilligoss and Rieh's (2008) model, the general rules accounted for a wide range of formats included by their research participants, such as books, other people, or the Internet. In this research project, the heuristic level represented the general rules adult learners employ when searching through science-based webpages on the Internet. These webpages are varied in format ranging from user generated sources to university generated sources to for profit agencies to nonprofit agencies. The heuristic and interaction levels investigated general rules participants used to identify and select credible science-based websites during an online search (Research Question Two).

Engaged layer: Study specific. In current times of polarized scientific topics (for example, climate change) and "fake news" accusations bombarding Internet-based learners, adults must make credibility decisions as they navigate online resources. Oftentimes, adults must critically evaluate credibility of information that contradicts information they hold as truth. To capture how information is evaluated by adult learners, specifically those not working or degreed in science-based disciplines, the final research question identified how participants evaluated credible controversial science-based information found online (Research Question Three).

To capture the actual process of assigning credibility, the study collected real-time data of participants engaged in decision-making and evaluation of credible information. Research design included avenues to explore participant definitions of credibility as it pertains to science information, identify general rules these adults employed when searching for online science information, and identify ways in which adults evaluate credible controversial science-information. In the following section, the research design is detailed.

Research Design

From the literature, the best approach to evaluate real-time computer searches was determined to be through a qualitative research approach utilizing participant observations and stimulated recall interviews. The following sections contain details on the study design and participant sample, including participant recruitment, selection criteria, and location information. This section concludes with discussion of data generations strategies and the approach for data analysis.

Participant Sample

Participants were purposively sampled based on a set of criteria to ensure a basic level of digital literacy, similar age group, and general interest in science. This criterion-based sampling approach as defined by LeCompte and Preissle (1993) is aimed at recruiting a specific number of participants sharing common attributes. The participant group was selected because they represented a subset of the adult populace actively engaged in online learning and tasked with learning new science information on the Internet without formalized training in the science-based content areas. The paragraphs below detail criteria used to select research participants.

Participant Criteria

Participants were selected based on a set of six criteria to ensure adequate digital literacy competencies, subject matter interests, and availability. Selection criteria for participants ensured the participants were 1) of similar age, 2) not considered science experts, 3) possessed an interest in learning more on controversial scientific topics presented through mainstream news, 4) knew how to conduct online information searches, 5) had transportation to the study location, and 6) had approximately two hours to volunteer for this research project. Of the thirteen interested adults, eight adults met criteria and were selected as participants.

Participants were of similar age and resided in the Savannah area. Research indicated Internet use of adults has increased over 30% in the recent years (Perrin & Duggan, 2015). To narrow down the target population while capturing similar Internet use patterns and get more validity in how adults navigate the Internet, I focused on recruiting participants aged 25-55. Due to low participant response, the final age range for participants was 24-57. Six of the eight participants were 25-55 years of age, one participant was 24 years of age, and one participant was 57 years of age. One interested female (age 18) who completed the initial contact questionnaire was not selected since her age was considerably less than the original age bracket. In addition to age, participants, though not required to originate from Savannah, were recruited and selected from the Savannah area because the research methods required face to face computer and interview sessions.

Participants were interested novices in the science content areas, not experts. Credibility decisions made in learning endeavors are impacted by the interests of the participant. If they have "no investment in interaction", then research indicated credibility was not a key factor in cognitive decisions made during the information search episode (Tseng & Fogg, 1999, p. 40). For this reason, the selected participants possessed a general interest in science, specifically, climate change and hydraulic fracking. One interested female (age 56) was not selected since she indicated no interest in climate change and fracking.

In addition to an interest in science, participants could not be considered as experts in the sciences, specifically, the fields of sciences pertaining to climate change and fracking. So, applicants with ecological, environmental, or Earth science backgrounds or employed in these disciplines were not selected. One interested female (age 25) was not selected as she possessed a bachelor's degree in Forestry and Conservation Sciences and had been working as an environmental educator at an informal science facility for several months. For the sake of this study, her degree and employment classified her as a "science expert." For considerations in this research, a "science expert" was defined as anyone perceived in having learned, academically or professionally, comprehensive knowledge in the identified areas of science. Avoiding science experts was important to keep the sample consistent. Earlier trials conducted in the research development stages indicated a tendency for those working and degreed in the sciences to conduct information searches differently than those not working or degreed in the sciences.

Participants were digitally literate. Research methods required participants to know how to conduct Internet searches. To meet this criterion, selected participants had to be capable of manipulating computer hardware (keyboard, mouse or touchpad) as necessary to conduct a basic Internet search. Participants possessed basic knowledge of available software that allowed them to select a web browsing program and initiate the computer-based searches.

Participants had time and transportation to assist researcher. Research sessions were conducted at the convenience of the selected participants, and each participant confirmed available time to allocate to this research study. Once selected, the research participants scheduled sessions based on their schedules (three scheduled sessions after the participants' work day had ended and five participants scheduled sessions on their day off). Additionally, participants were required to have transportation to the research location. This became an issue for one female participant (age 26) and she withdrew from the research project.

Participant Recruitment and Selection

Participant recruitment began April 2017 and continued through June 2017 when eight participants were selected. Participant recruitment involved dissemination of the recruitment flyer (Appendix A). With permission, the flyer was distributed at four Savannah area libraries, two community centers, and one informal science education facilities. The facilities were centrally located in the city of Savannah and not too distant from the research location. Several facilities promoted the research participant opportunity through their brick and mortar facilities as well as through their email list serve and social media outlets.

The IRB approved flyer gave an overview of the research project, participant expectations, and gift card of appreciation. The flyer asked interested participants respond by contacting me via a text message to my personal mobile phone. Providing one mode of contact was intended to ease management of respondents. Unfortunately, there was a low response from recruitment at these facilities which caused additional flyer distribution through social media (Facebook) and a nonprofit marine education organization with members interested in science, but not classified as science experts.

As participants responded, I verified they met research criteria by asking them to complete the Initial Contact Checklist (Appendix B). Participants satisfying the selection criteria were notified and asked to establish a computer research session date and time. Participants were thanked graciously for their willingness to assist in the study, reminded of a compensatory gift card in gratitude of their volunteered time, and asked permission to contact them with a session reminder a few days ahead of their scheduled session.

As the research session grew closer, participants were sent a text reminder regarding their scheduled research session with directions to the research location. Participants also received a final text the morning of their scheduled research session. All participants arrived in a timely fashion. Eight participants completed both the computer portion and the stimulated recall interview. Each of the eight participants received a $25 gift card to their choice of Starbucks or Panera. Table 2 details the participants identifying them by the researcher selected pseudonym.

As indicated in the criteria list, all eight participants had basic digital literacy skills to search for information online and each had an interested in fracking and climate change. No participant was considered an expert in these subjects. Backgrounds of the participants varied as did their age. Six of the participants had non-science degrees with four of these working or looking for work in the field of education. Leslie and Joan had science-based degrees, but these professionals were both in the medical field of vet and human health which did not make them an expert in the subject matter of this research study. Participants were born within 33 years of each other with the eldest participant

Table 2. Participants and Background

Participant (Pseudonym)	Current Job Title	Birth Year	Degree
Addy	Currently Unemployed/ Seeking Employment	1965	BA in Special Education
Alice	Staff Attorney for State Court Judge	1976	BA in American Studies: JD in Law
Christy	High School English Teacher	1989	MSA in Curriculum Writing
Joan	Nurse Practitioner	1960	RN in Nursing
Julie	Teaching Assistant	1993	BA in Classical Culture
Kelly	Retail Manager	1962	BA in Accounting
Leslie	Veterinarian Technician and Receptionist	1985	Certificate in Veterinary Science
Nathan	High School Math Teacher	1977	MS in Math Education

born in 1960 and the youngest participant born in 1993. Three participants, Joan, Kelly, and Addy were born in the 1960's. Two participants, Alice and Nathan, were born in the mid 1970's. Two participants were born in the mid to late 1980s and one participant was born in the early 1990s. As mentioned earlier, due to low response, Joan and Julie were selected as participants despite falling slightly out of the originally intended age bracket of 25-55 by two years and one year, respectively.

Research Location and Setting

All research sessions were conducted in the same large (10 ft X 20 ft) conference room located in a University System of Georgia facility in Savannah, Georgia. The location was selected because this facility is well known to many living in Savannah, and participants had access to ample free parking. This location also offered a strong, consistent Internet connectivity to support an extended computer search and it provided convenient restrooms for the estimated two-hour long research sessions.

Data Generation

This research project explored how adults evaluated science-based information and identified criteria used in determining science information credibility. The following section discusses the procedures for each part in more detail identifying the type(s) of data collected in each part. Each participant took part in a two-part research session, shown in Table 3 which was based on methodologies used by Butefish's (1990).

In his research, Butefish (1990) video recorded teacher participants' behavior in real-time to capture how they engaged with their situations in the classroom. The video created during Butefish's (1990) real-time situation created the artifact guiding the second part of his research session, the stimulated recall interview portion. During the stimulated recall interview, the participant guided him through the video playback narrating their decisions and actions. Participants' narratives provided insight to their cognitive processes and their decision making during tasks without interrupting their tasks.

Table 3. Two-part Research Session

Stage	Time	Description
Computer Session	20-30 minutes	Participants engaged in a task-oriented Internet search for science resources and information. Screen recording captured their information searches.
Break	5-10 minutes	Participant took a small break while I reset the computer and prepared for the interview.
Stimulated Recall Interview	20-75 minutes	While playing back video of recorded session, the participant guided me through their search identifying criteria used to make navigation decisions. Screen recording captured search video playback and narration audio.

Butefish's (1990) methodologies were a good fit for adaptation and use in my study on participants' real-time computer search as it granted a way to capture real time behavior that could be played back for the participant to narrate their thoughts and decision-making process. However, to ensure a good methodological fit for this research, the two-part research session format and software to be used was piloted (two field tests and an expert review) in Fall 2016. The pilots assisted in the development of research specific protocols while providing time to evaluate software capabilities, research location, and computer and interview prompts in real-time. Summaries of the pilots are provided in Appendix C and an overview of the objectives from the preparation phases is presented in Appendix D.

Research sessions

Eight research sessions, comprised of a computer search session and stimulated recall interview, were conducted. With each session, participants were asked to conduct two information searches, one on climate change and one on fracking. In total, the eight participants conducted sixteen searches. Adapting Butefish's (1990) observation and stimulated recall interview to include more contemporary technologies in data generation and analysis afforded the best way to capture participants' thoughts as they reflected on their computer search. This methodology allowed participants the opportunity to talk through their decisions during the stimulated recall interview which occurred after the problems had been solved rather than during the problem-solving task.

Hilligoss and Rieh (2008) discussed the personal nature of credibility decisions as did Rowe (2009) who advised these types of interviews to be conducted on a one-to-one basis. I engaged with each participant on an individual basis, recording each search and interviewing each participant individually to prevent external or perceived influences on credibility decisions. The most important facet of this research study was the collection of real-time data representing actual search behavior data, not post search or perceived search criteria. Real-time data on participant Internet use versus perceived data of Internet use eliminates inaccuracies that come from self-reported data (Scharkow, 2016).

As detailed in Table 2 above, the present study was comprised of two parts, similar to Butefish's (1990) study. During Butefish's study, participants were recorded during an observed task then asked to narrate their cognitive processes during the task while watching a video of their task. Specific adaptations to this part of Butefish's (1990) methods pertained to imagery of the participants. The present study took focus away from the image of the participant as the task was conducted and shifted focus to the participants' decision making and behavior, specifically their computer information search. The cursor movement and the images on the computer screen were recorded along with any vocalizations made by the participant during the search, but no image of participant was recorded at any time during the research session.

With technological advances in video and audio recording capabilities, the modes of video and audio have been modified from Butefish's (1990) research methodologies. Butefish (1990) had used technologies of his time which were a video recorder, TV, and VCR. Video and audio for the current study's research sessions were captured using TechSmith's Camtasia Studio 8 software, handheld Olympus audio recording device, and a laptop computer. The following sections discuss both parts of the current research study in detail.

Research session: Part one. The first part of each research session was comprised of a self-regulated Internet search for science information and it was conducted on a laptop computer. This initial part of data collection was referred to as the *computer session* and provided the time for each participant to take a self-directed learning approach to locate and evaluate credible science-based information on the Internet. Each participant researched the same two controversial scientific terms, fracking and climate change. The computer prompts, listed in Table 4, were presented on a sheet of paper to each participant as they sat down to begin the computer search portion of the research session.

Table 4. Computer Prompts for Part One.

No.	Question
1	What is meant by "fracking" and why are some individuals concerned about this process?
2	What is meant by "climate change" and why are some individuals concerned about this process?

Participants arrived on an individual basis at the research location prepared for their prescheduled two-hour research session. I met each participant at the front door and escorted them to the upstairs conference room. Once to the conference room, I reviewed the University of Georgia's Institutional Review Board (IRB) consent form (Appendix D) and discussed any questions participants asked. Afterwards, participants were asked if they wished to continue their involvement in the research. All participants elected to proceed, and each signed the IRB consent form.

To capture the most natural uninterrupted search behavior, a non-intrusive screen capture program by TechSmith, called Camtasia Studio 8 was used for data collection. Camtasia Studio 8 allows for simultaneous computer screen and audio capture which afforded me the opportunity to record the participants' Internet searches in real-time. The software captured cursor movements, webpage selection, length of time spent on each web-based resource, and audio when the participant spoke during their search.

At this time, participants were seated in front of the research laptop (a 15" Dell Inspiron laptop operating with Windows 10) and asked to complete searches for both questions presented on the Computer Questions Sheet (Appendix E). Three options for web browsing (Microsoft Edge, Google Chrome, and Mozilla Firefox) were offered on the research laptop. The laptop's desktop area remained clear of distractions and personal files during the research period which ran from April 2017 through to July 2017. While no specific time limit was placed on the participants' search sessions, a thirty-minute suggested time was offered. Despite this time caveat, participants were encouraged to take as much time as they deemed necessary to answer the questions.

Camtasia Studio was manufactured for those interested in creating screencasts but was easily manipulated for the research purposes and selected methods. I began recording when the participants began their searches and captured all screen movements. Camtasia Studio also captured episodes of participants speaking to me or talking through their thoughts out loud. Participants' initial computer search file was recorded then played back for review, comment, and discussion during the stimulated recall interview. During the stimulated recall interview, a new file was created containing original footage, playback activity, and discussions during the playback.

To avoid thought interruptions and prevent a distributed practice effect as discussed by Kupper-Textzal (2014), participants received one sheet of paper listing both science questions (as noted in Table 2) and asked to answer both questions prior to our follow up stimulated recall interview. While all participants were conducting their searches, I sat at the far end of the twenty-foot conference table silently engaged in other projects so that participants would not be drawn to engage with me during the computer search session. When participants indicated their search was complete, I stopped the screen recording software, and encouraged participants to take a short fifteen-minute break to stretch their legs or use the restroom. This break provided time for me to save their computer search video file and prepare a new file to capture the playback video and audio from the stimulated recall interview.

Research session: Part two. The second part of data collection was the *stimulated recall interview*. Research on appropriate methods indicated stimulated recall interviews were the preferred data collection method since the present study aimed to capture participants' actions without interrupting their naturalistic problem-solving process (Koro-Ljungberg, Douglas, Therriault, Malcolm, & McNeill, 2012). Once the participant returned, we sat in front of the laptop and I started a new recording file of our stimulated recall interview to capture interview audio and screen movements made while watching their original computer search session. For consistency in research, I recited the scripted introduction at the top Stimulated Recall Interview Guide (Appendix F) to outline expectations of the interview for the participant and assist me in keeping focus on the three research questions.

Hilligoss and Rieh (2008) stated that assessing credibility is an internal process which might prove difficult for learners to articulate. Assisting participants with articulating their thoughts is crucial, yet it is important to not mix the words of the researcher into the words of the participant. To assist participants in articulating their thoughts, open ended prompts were used during the stimulated recall interview; for example, "Can you tell me more about ______?", "You said ____, what did you mean by that?".

As mentioned earlier, the methodology for the stimulated recall interview was also influenced by Butefish's (1990) research design in which he asked participants to guide a video playback during a stimulated recall interview portion. Using the video as a guiding artifact, Butefish (1990) asked his participants to identify and stop at each decision point. He tasked the participant in identifying these points as he found the participants were more effective in identifying upcoming decisions points. During each stimulated recall interview for this study, participants were similarly tasked to guide the video playback of their Internet search, narrating their search and describing their thoughts on resource selection. When decision points were skimmed over by the participants, I rewound the video playback of their search and inquired about those decisions.

When the original screencast video of their Internet based searches had ended, I continued recording any discussions using the Camtasia Studio 8 software. Once all talk regarding their searches was captured, the interviews were concluded, and participants were offered a $25 gift card to Starbucks or Panera. When the participant accepted their gift card, I stopped audio recording on the handheld Olympus audio recorder and closed the file being recorded in Camtasia Studio 8. Search files and interview files were saved as follows FirstNameInitialLastNameInitial_Search_SessionDate and FirstNameInitialLast Name Initial_Interview_SessionDate

Data Sources and Data Analysis

With multiple files for each participant and data collection lasting several months, the data generated was high in volume and differences in collecting strategies seemed probable. To stay aligned with the research session conversations, I listened to the interviews and played research session audio and video files multiple times in efforts to stay close to data and maintain consistency in methods. This section identified the data sources and the approaches used to prepare for data analysis of those sources.

Data Sources

From the two-part research session, data was generated from five sets of artifacts. Table 5 presents the data sources including a brief discussion of each source. The remainder of this section details contents for each data source and my rationale for creating the data source.

Table 5. Data Sets Generated and Description of Each Set.

Data Source	Description
Initial contact checklist	Paper-based questionnaire providing participant demographics, science background/degree, and session information.
Computer search session video file	Camtasia Studio 8 file of each participants' fracking and climate change search on the laptop.
Stimulated recall interview video file	Camtasia Studio 8 file of each participants, stimulated recall interview session following their computer search session.
Stimulated recall interview transcript	Audio file of the stimulated recall interview collected via handheld Olympus audio recorder.
Field notes	Observational notes collected during research sessions and while viewing computer files and audio files.

Initial contact checklist. Since research criteria had to be met by each participant, the initial contact checklist provided the mechanism for collecting information and narrowing down interested applicants to research participants. Demographic information, science background, science interest, and availability to participate was collected and compiled. Also, the checklist indicated the participant's contact information and research session information.

Computer search session video file. Each participant's computer search was recorded with Camtasia Studio 8 software and saved accordingly. Field notes from this collection of artifacts included notes on websites visited, length of stay on each website, websites passed over or paused on but not selected, and which web browser and search engine was used. Web browser is defined as a software program installed on one's computer which is used to access to search engines (www.Dictionary.com/browse/web--browser). Examples of common web browsers are Internet Edge, Mozilla Firefox, Google Chrome, and Safari. A search engine is also a software program, but it is driven by search terms entered by each computer user. Search engines search the Internet for terms and compile results into a list for the user to review (www.Dictionary.com/browse/search-engine). Examples of common search engines are Google, Bing, and Yahoo. Field notes were made as needed during this time.

Stimulated recall interview video file. The stimulated recall screencasts were watched after viewing the initial computer session video. Watching the participants' Camtasia Studio 8 computer search files prior to the Camtasia Studio 8 stimulated recall interview file allowed a level of connection to the participants' behavior and their navigation patterns leading up to their decision points. This insight afforded an experience of their search in real time before focusing on their narrations in the stimulated recall video file. During this time, field notes were taken to enrich earlier notes on websites visited, length of stay on selected resources, incite to why other resources were passed over or paused on.

Stimulated recall interview transcript. Interviews were transcribed throughout the research period to provide feedback on areas for improvement given my novice interview status. Interviews were transcribed using audio files from the Olympus handheld audio recorder. This draft was then edited using audio from the Interview file. Transcripts were enriched with field notes as described below throughout the transcription process.

Field notes. Field notes were taken during the research sessions, during the researcher review of the computer search file, and during the researcher review of the interview file. Initial notes include those taken during the initial consent discussion and participant checklist review. I remained in the same room as all participants during their searches poised to take notes on what I observed. Field notes taken during the research session included any observations made during the participants' computer search portion, any formative thoughts on how to modify future research sessions, and key words or phrases mentioned during the interview which served as reminders to be revisited with the participant.

Other sets of field notes were taken after the research session when watching the computer search and interview files. Computer search field notes listed out the websites visited, paused on, or passed by. Field notes collected on the webpages visited by participants during their search session included the number of times the webpage was visited, the length of time each webpage was visited, and the webpage URL. Because no eye tracking devices were utilized, this time cannot be equated to time engaged in the resource as participants might be looking off screen. Field notes taken during observations of the computer search and interview files added data pertaining to participants' rationales in resources selection, observations on webpage credibility, and thoughts on the science-based resource.

For consistency and to stay close to the data of each participant, the following procedures were followed when entering analysis for each participants' collection of data. Camtasia Studio 8 search files were viewed in their entirety at real-time speed capturing information pertaining to their search patterns and resource selections. Then the participant's audio files, recorded on an Olympus handhold audio recorder, were reviewed to assimilate the information from the search while focusing on the participant's words. The third step in analysis was the transcription of the audio files to put the participant's words on paper. Next, interview files were watched and data pertaining to website names and web addresses were inserted into the transcripts. At this time, modifications to transcripts were made if edits were warranted. Using audio and video files to create a transcript was beneficial in analysis as I found great benefit from hearing the interview while watching the participants screen actions. Enriching each transcript with the online behavior information gleaned from the computer search file assisted in analysis by providing behavior details to clarify texts of the transcripts.

Lastly, each website accessed by a participant, paused on by a participant, or passed by was recorded in a data spreadsheet. Webpage sponsor and date were recorded for all resources when available. For each websites and resources that participants accessed, the length of visit was recorded based on-screen time. Web browsers and search engines utilized for each search was also recorded.

Data Analysis

Once a session had been completed, data analysis began. For consistency, data generated from each session was analyzed as follows. Initial coding began in the second step and continued through each additional phase. This section discusses the procedures in data analysis and the approach to code and theme development.

Procedures

Steps for analysis were repeated for each participant. The steps were:

1- View search session video file

2- Transcribe audio file

3- View stimulated recall interview file

4- Re-watch stimulated recall interview file

5- Review field notes

6- Finalize themes

View search session. Saldana (2016) encouraged those collecting video data to watch the video in full before analysis to gain a holistic sense of the participants' thoughts during the search. So, each participants' computer session search file was watched in full taking field notes on websites visited, paused on, or passed by. Time spent on each topic, fracking and climate change, was also recorded as well as time spent on the webpages that had been selected for use in their search. Viewing each session prior to analysis provided a reconnect with the participant and their research session especially if a day or two had passed between research session and data analysis. Field notes were taken on general search behaviors including selected web browser, search engines, search terms, and overall search times.

Transcribe audio. Four interviews were solely transcribed by slowing the recording speed of the audio file captured on the Olympus handheld device. The remaining four transcripts were professionally transcribed and underwent intense review upon their return so I could stay close to the words of these participant. The initial drafts of the audio transcripts provided an advanced starting point in putting words to paper and were edited the same as the four initially transcribed interviews.

View stimulated recall interview. During this very time-consuming step in the analysis procedures, edits were made to the transcript drafts. At this time, details pertaining to the websites and resources were added to the participants' transcripts. These details included website titles, time allocated to websites and resources, time allocated to searching for fracking information, and time spent searching for climate change information. Also, during this step, I noted observational events (pauses in cursor movement, resource selection, scrolling through resources, revisiting a resource, etc.) as Probst, DeAgnoli, Batterham, and Tapsell (2009) stated these events are characteristic of decision points from their research in which they generated video recording data to analyze.

Re-watch stimulated recall interview. All sessions were watched at least twice, but several sessions warranted additional viewing once or twice more as salient themes arose. These additional previews ensured all data was captured given the saliency of codes and themes as the process progressed. During this step an excel spreadsheet was created to capture participants' web browser preference, search engine preference, search terms, time spent on the accessed websites and resources, title of resource if identifiable, sponsoring agency if identifiable, publication/update date is identifiable, and domain type of resources selected, paused on or passed by.

Review field notes. Field notes pertained to the participants' search and navigation behavior. Valuable field notes collected in the procedures detailed were compiled into the spreadsheet. This data provided the total search time the participants had resources opened, percentage of their time engaged with resources and webpages, the number of resources selected during their searches, and the percent of resources selected during their searches.

Finalizing themes. Data analysis occurred throughout data collection. The field notes and transcripts generated data involved multi-tiered coding strategies as described by Saldana (2016) where the data is coded, recoded. Codes were based on saliency of the themes and evolved as new codes when themes were created or merged. Given the nature of visiting and revisiting the data, I assumed a constant comparative approach as described by Charmaz (2014). Assuming this approach kept me close to the data to avoid misinterpretation while providing many opportunities to look for similarities and differences across and between participants. Once all data was coded from the transcripts and the computer search files, the initial data analysis phase was considered complete.

The initial codes were based on words or passages having relevance to similar words or passages and linking back to the research questions. No data was excluded. When a word or phrase emerged and was repeated across several transcripts or when I find value in their uniqueness, the word or phrase was coded and held for later consideration in the findings. The initial codes were revisited and regrouped until assertions could be made. These assertions were then crafted into themes which best represented the data generated from the participants. As noted by Saldana's (2016), themes were not forced from any prior work or research as I wanted assertions to stem strictly from the data derived in my research. Themes were then compared to the selected layers of Hilligoss and Rieh (2008) mentioned in previous chapters. Of these themes, several could be applied as responses to the research questions and others are applied to additional findings pertaining to adults' online task behavior.

Methodological Quality

Establishing and maintaining quality research is important. Mason (2002) stated that "qualitative researchers should be accountable, and their research should be rigorous and of high quality" (p. 40). In order to have a high-quality research study, qualitative research scholars advise researchers to maintain quality throughout the entire process (Roulston, 2010), from the time one starts to collect quality data (Charmaz, 2014) to the time one presents the data appropriately (Preissle & Grant, 2004). During the analysis phase, literature suggested for researchers to be critically reflective on their data and analysis processes (Mason, 2002) to maintain trustworthiness (Ravitch & Riggan, 2012).

To ensure quality in this research, the following strategies suggested by Roulston (2010) were a part of the research design and analysis: data triangulation, inclusion of a subjectivity statement, and member checking. Data triangulation is a common strategy allowing a researcher to use data collected by multiple methods or multiple collection strategies to yield a more complete data set (Roulston, 2010). Triangulation was accomplished in this study through use of multiple data sources (observation, interview, and field notes) and various forms of data (printed transcripts, audio files, and video files) (Roulston, 2010). According to Creswell (2003), including all data, not just supportive or positive data, affords trustworthiness. All data gleaned from the participants has been considered during coding and has been provided in the findings; thus, removing an air of biasness. Data aligned to the research questions were categorized accordingly and data extending beyond research questions have also been categorized.

Secondly, research is considered more trustworthy with inclusion of a researcher's subjectivity statement detailing their positionality towards their study. As suggested by Roulston (2010), I included a subjectivity statement in this publication which discusses any researcher biases and notes the notable events leading me to this present study and highlighting my positionality on the research study. The subjectivity statement is intended to offer insight into my decision-making rationales in data collected, codes identified, and analysis (Roulston, 2010).

Lastly, member checking was a quality control strategy offered to participants. Member checking is the opportunity for participants to check the interpretation of data (Roulston, 2010) or read through their transcripts to check its accuracy (Fraenkel & Wallen, 2006). While offered to participants, no participant elected to review their transcripts. In addition to these strategies, many hours were spent generating data from the research sessions in effort to include all salient findings. These long hours spent listening and watching data, provided a "deeper and more complex understanding" to cognitive processes supporting the decisions made by each participant (Roulston, 2010, p. 84). Through this deeper understanding, I was able to more accurately describe and interpret behaviors and decision-making characteristics.

Ethics in Research

Participant safety is paramount in all aspects of research. While this research study's design plan was not classified as a risky venture for participants, precautions were taken since human subjects were involved. Participants are identified though pseudonyms and research subject approval from the University of Georgia's Institutional Review Board (IRB) was sought and granted.

Once the IRB had been approved, research flyers were distributed and participant recruitment for this study began. Data is to be handled as follows. Computer files and field notes collected will be destroyed in time: audio files from the interviews will be deleted upon graduation, copies of the transcripts and Camtasia Studio 8 computer search and interview files will remain on my laptop, cloud storage, and external hard drive for up to two years after I graduate, and field notes and personal information sheets will be destroyed upon completion of the study. In the next chapter, discussion will focus on the data analysis and the research findings.

CHAPTER FOUR

FINDINGS

Adults, specifically those with non-science degrees, select and identify credible science-based online information in a variety of ways. The following chapter presents the findings of the present study which was guided by the following questions:

1- How do non-science experts discern *credible science information*?

2- What general rules and cues do participants use to select credible science-based websites during an online search?

3- How do participants evaluate credible controversial science-based information found online?

This study's findings are multi-dimensional and are presented in three parts. Part one includes an overview of the participants' approach to the online information search. Part two includes the findings as they relate to the three research questions, and part three presents additional findings from the study that do are not linked to the prior two parts pertaining to the participants' approach or to the research questions. These additional findings include data on participants' emotional experiences while conducting their searches, constant consideration of time spent searching, the idea of answering the computer search questions "correctly" or "incorrectly," and the obligatory notion of adult learners being forced to become a facilitator of their learning.

Participants' Approaches to the Computer-based Information Searches

The present study sought to offer participants a naturalistic online learning endeavor in which they sought information to formulate a response to two science-based computer questions pertaining to two controversial topics, fracking and climate change. Identified as necessary in the research study pilot, a suggested time limit was provided at the start of the research session to assist participants in framing their search. While a suggested search time limit of thirty minutes was indicated, participants were encouraged to take as long as they needed to craft a response and each participant was reassured there was "no rush."

During the science-based computer searches, participants spent approximately 4.56 hours researching both topics with 2.4 hours spent on the topic of fracking and 2.16 hours spent on the topic of climate change. Table 6 details the cumulative search times and specific topic search times for each participant. Seconds was the preferred choice of time keeping as it allowed for ease in calculating time spent per resource and ease in comparing time spent on search topics. Conversions have been made to minutes and hours for ease of presentation in tabular form and where needed to aid in communicating the findings.

Individual search times varied from 21.7 minutes (Alice) to 47.3 minutes (Leslie). The average search time for the eight participants was 34.2 minutes which was close to the thirty-minute search time suggested from the pilot's finding. In comparing the searches per topic, the fracking search times varied from Addy's search time of 11.3 minutes to Leslie's search time of 26.6 minutes. The climate change search times also had a level of variability in time spent searching. Christy spent 9.3 minutes searching for a response to the climate change question and Kelly spent 20.4 minutes researching the same question.

Table 6. Participants' Search Times (in minutes).

Participants	Total Search Time	Fracking Search Time	Climate Change Search Time
Addy	29.7	11.3	18.4
Alice	21.7	11.7	10.0
Christy	24.5	15.2	9.3
Joan	35.7	18.4	17.3
Julie	41.5	23.5	18.0
Kelly	31.7	11.3	20.4
Leslie	47.3	26.6	20.7
Nathan	41.5	25.7	15.8
TOTAL	**273.6 minutes (4.56 hours)**	**143.7 minutes (2.4 hours)**	**129.9 minutes (2.16 hours)**

Seven participants completed searches for fracking and climate change in one un-interrupted search period, Leslie did not. Leslie conducted the computer search for fracking then indicated she was ready for the follow up stimulated recall interview; however, it became apparent during the stimulated recall interview that she had not completed the climate change information search. Once the fracking stimulated recall interview was completed, Leslie conducted the climate change information search. Once the climate change search was complete, a second stimulated recall interview focused solely on the climate change search was conducted to cover both topics and collect both sets of data from this participant.

Software Preferences for Science-based Information Searches

To maintain a naturalistic approach, participants were encouraged to use the computer and Internet programs familiar to them, specifically in selecting the web browsing and search engine software. Web browsers and search engines are two types of software used to conduct online searches. Web browsers are locally downloaded software programs utilized to access the Internet, not to be confused with search engines. Examples of web browsers include Safari, Google Chrome, and Microsoft Edge (formerly Internet Explorer). The second type of software involved in a computer search for information is known as a search engine. Search engines are online-based programs used to access the Internet using algorithms to search virtual resources for specific key words or phrases, commonly referred to as 'search terms.' Examples of search engine programs include Google.com, Bing.com, and Yahoo.com.

Web browser preference seemed to be linked to those using Apple brand devices. Five participants indicated no preference in web browser software, while three self-identified Apple brand users, Julie, Christy, and Nathan, indicated they would have preferred using Safari since they are more familiar with the software. The remaining five participants indicated no preference on web browsing software programs. Conversely, there was a strong preference in search engine preference among the participants. Seven of the eight participants indicated a preference for a search engine software program known as Google.com. These participants were Joan, Julie, Leslie, Addy, Christy, and

Alice. Several participants indicated preference of a software program over another software program, Bing.com. For instance, Joan stated she preferred Google[.com] because "it's just easy and simple to me. And it has a lot of ... it tends to be fairly broad..." Leslie echoed the ease of use statement when she stated that Google[.com] "just seemed to know a lot more than…versus Bing[.com] and the other search engines."

Alice indicated she was completely dedicated to Google.com because of the quality and pertinence of her search results. She stated " [I] did experiments, maybe a year ago, no it was longer than a year ago, and I found that Google[.com] would get [the search results] closer to what I was looking for. I felt like Bing[.com] was all over the place, so I'll stick to Google[.com]." At one point in her search, Alice inadvertently navigated away from Google.com and conducted some of her search using Bing.com. In narrating this portion of her search during the stimulated recall interview, Alice stated that "here's when I realized- No, I'm on Bing[.com]. I don't want to be on Bing[.com]. So, I go to Google[.com]. And here's what I'm thinking- oh wait, ok. Now I'm on Google[.com] and I'm happier."

The following Figures 2 and 3 offer visual representation of the web browser and search engine preferences used by the participants during their searches. Figures 2 depicts the web browser and search engine combinations used during the search for fracking resources and Figure 3 pertains to the software program combinations used during the climate change resource search. While no single software combination was used a majority of the time in the fracking information search, Google Chrome and Google.com was attributed to 31% of the search results for fracking resources, see Figure 2. Google Chrome was used as the web browser to yield 51% of the fracking resources and

Google.com was used as the search engine to yield 46% of the search results. This tally does not include the GoogleScholar.com search engine results.

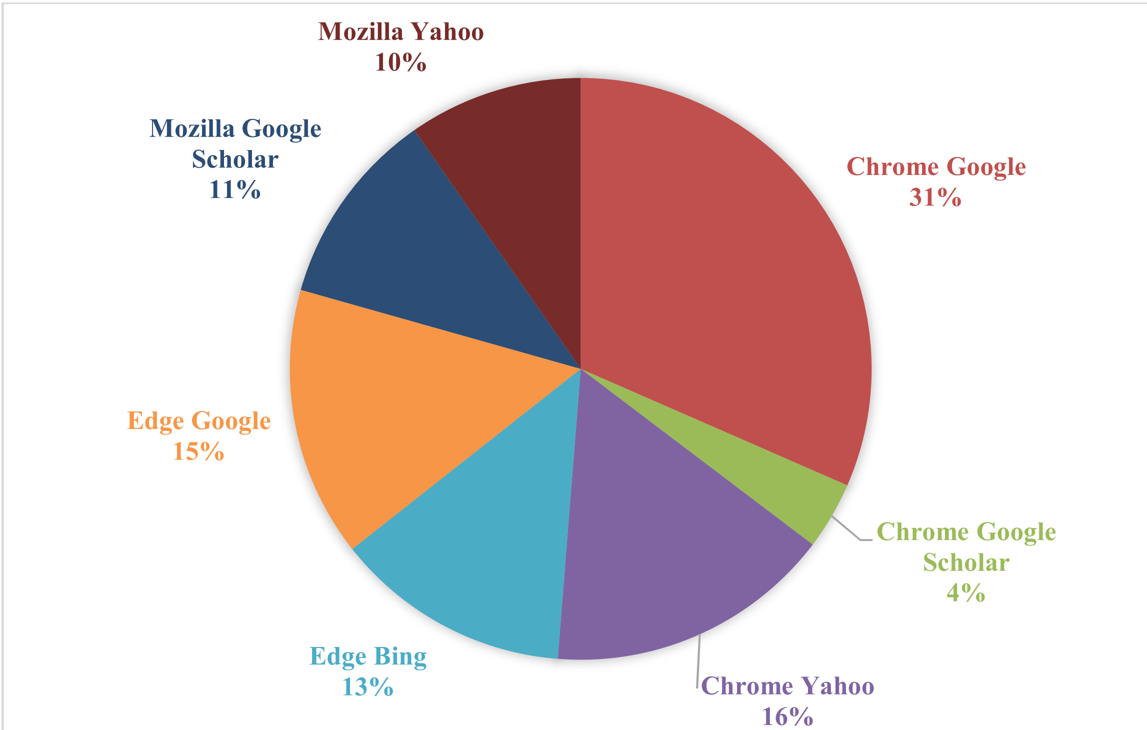

Figure 2. Web Browser and Search Engine Selections: Fracking Search

In the climate change software selections, Figure 3 indicates participants preferred a different combination of programs. Google Chrome and Yahoo.com was used to yield 30% of the climate change resources and Mozilla Firefox and Google Scholar.com was used to yield an additional 28% of search results. In looking at web browser preference, Google Chrome was used to locate 44% of climate change resources and Mozilla Firefox was used to access an additional 36% of climate change resources. GoogleScholar.com was the preferred search engine for climate change resources as this software was used to yield 35% of resources and Yahoo.com was close behind as it was used to access an additional 30% of the climate change resources.

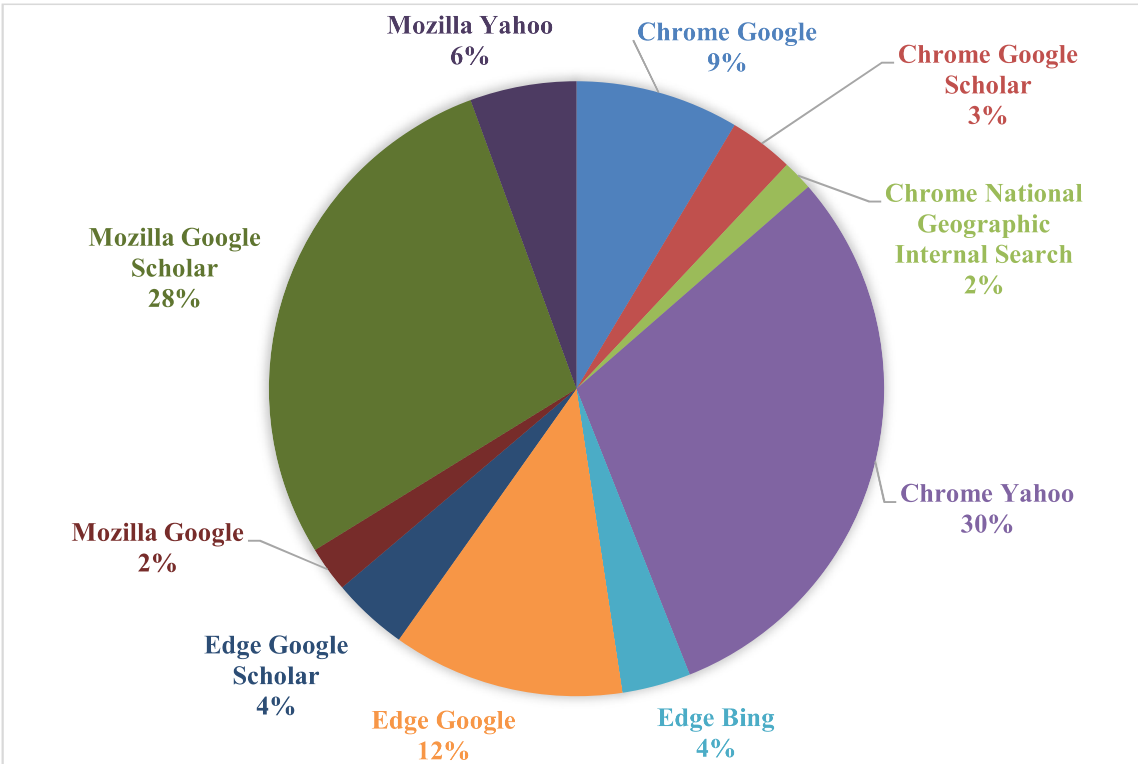

Figure 3. Web Browser and Search Engine Selections: Climate Change Search

Selecting Search Terms

After selecting the web browser and search engine, participants then crafted original search terms or selected from the "suggested" search terms provided by the search engines at the time of their search. From these results, participants selected resources and engaged in evaluation of the online science-based resources. Table 7 and Table 8 present search terms entered or selected by participants selected suggestions appearing in the search field as they typed in their search phrase. Entries marked with an asterisked (*) are entries where the participant typed in the first portion, then selected a search engine filter to narrow down the results. While most search terms were directly entered by the participants, a small percentage of the search terms were initiated by the participants but completed by the search engine software. The search histories were cleared prior to each participants' research session except for Leslie, so the auto filled search terms were based on the search engine not the computer's search history.

Table 7 identifies the 21 search terms the participants entered when searching for fracking information. As mentioned earlier, search terms were either entered directly by the participant or selected from the search engine suggestions as they typed their search term. From those search terms used in the searches, two search terms "what is fracking" and "fracking" were prevalent among participants. Four participants (Alice, Julie, and Joan) decided on the "what is fracking" search term and five participants (Addy, Christy, Leslie, and Nathan) used the "fracking" search term.

Search terms varied, as did the number of search terms utilized by participants during the search. Addy and Christy used two search terms during their fracking information search while Alice and Kelly used one search term to locate enough credible resources to formulate a response to the fracking question. Two participants used six or more search terms to access credible information for the fracking computer question, these participants were Leslie and Nathan. Leslie utilized six search terms during the fracking search and Nathan utilized eight search terms.

Table 7. Participants and Search Terms Entered: Fracking Search

Participant	Search Term
Addy	Fracking Fracking article National Geographic
Alice	What is Fracking
Christy	Fracking Fracking in the U.S. controversy
Julie	Fracking controversy: case law* Fracking controversy: since 2013* What is fracking Why are some people concerned with the fracking process
Joan	What is fracking What is fracking and what are its Environmental impact Why is fracking bad
Kelly	What is fracking
Leslie	Fracking Fracking Meaning Fracking pros and cons Risk of Fracking Shale Rock What does fracking mean?
Nathan	Diagram of fracking process Environmental Science and Technology Fracking Fracking: Past Year* How Stable is shale after fracking How Stable is shale after fracking and earthquakes Marcellus Shale What happens to the water used in fracking

Participants had various approaches in identifying sources when searching for results. Addy sought results strictly from a known website (National Geographic) and selected “fracking article” from a National Geographic specific search engine. Search terms indicated instances when participants, specifically Julie and Nathan, used search engine filters to limit search results. Julie used search result filters to limit search results to case law and by date and Nathan used filters to yield results published in the past year.

Figure 4 displays the results of the search terms used during the fracking information searches. This figure shows each search term with the number of resources resulting from each search term. The numbers listed by the search terms represent the total number of resources made available for the participants to access, not the number of resources with which the participants engaged. Resources participants engaged with is provided later in this chapter. Participants entered 21 unique search terms resulting in 320 fracking resources. The two most common search terms, “what is fracking” and “fracking” resulted in the highest yield of resources, 106 and 35, respectively.

Search terms for climate change are presented in Table 7 which displays the 26 search terms used by the participants during this portion of the computer search. Participants used two (Addy, Joan, and Kelly) to seven (Alice and Leslie) search terms. Overall, participants entered 26 unique search terms while looking for climate change information with two search terms being used my multiple participants, these common search terms were “climate change” and “climate change effects.” As with the fracking search strategy, Addy sought information on specific webpages (BBC, National Geographic, and Discovery Channel) and Julie used filters provided by the search engine to limit publication dates of search results.

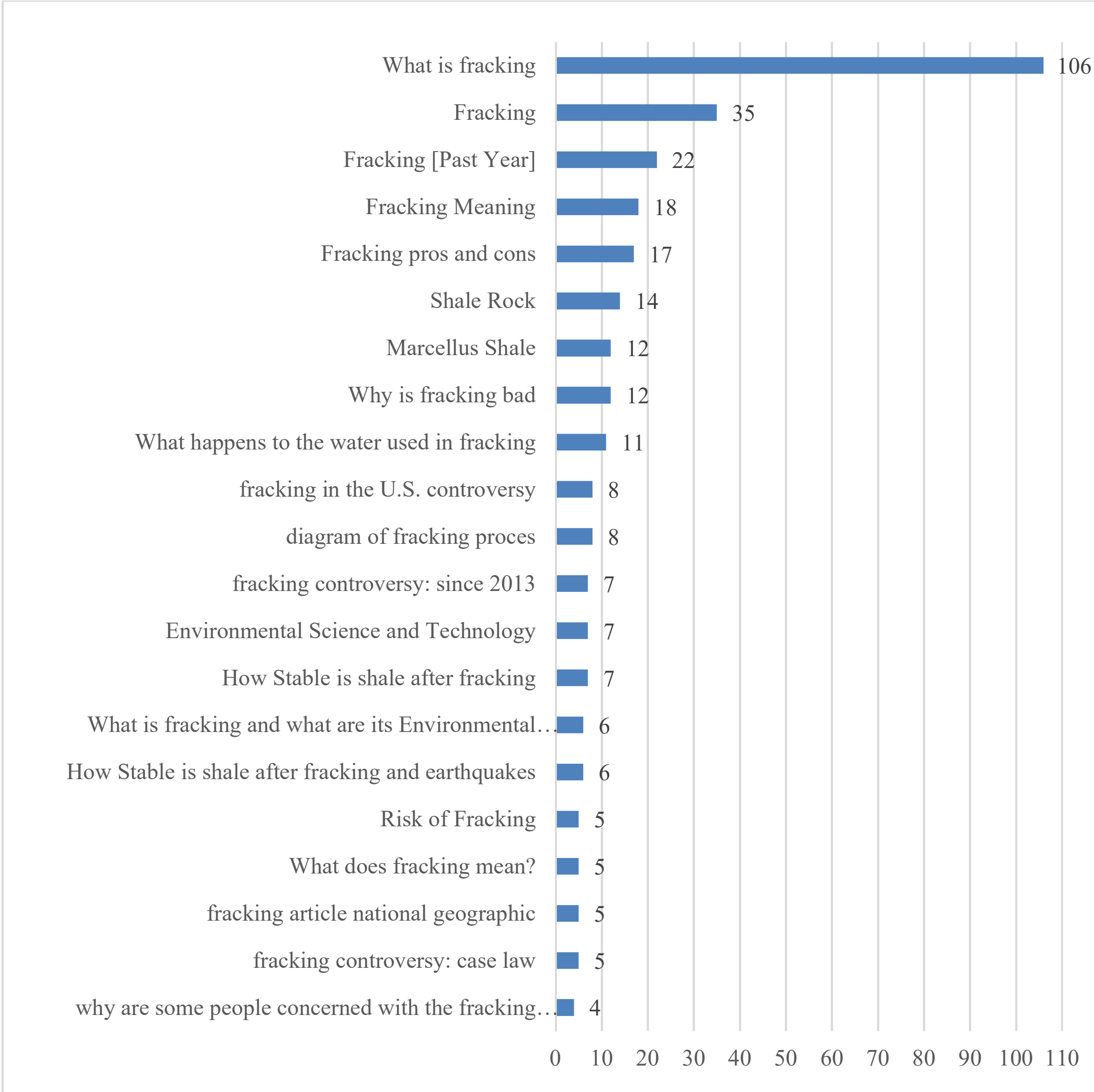

Figure 4. Number of Resources Returned Per Search Terms: Fracking Search

Figure 5 shows the number of resources resulting from each search term used by the participant. “Climate change” was used by six participants (Addy, Alice, Julie, Joan, Leslie, and Nathan) and resulted in 109 resources. “Climate change effects” was used by two participants (Addy and Leslie) and resulted in 75 resources. Overall, these two search terms resulted in 36.8% (184 resources out of 500 resources) of resources in the climate change search results.

Table 8. Participants and Search Terms Entered: Climate Change Search

Participant	Search Term
Addy	Climate change Climate change BBC Climate change National Geographic Global Warming Is global warming still a theory Is global warming still a theory 2017 Is global warming still a theory Discovery Channel
Alice	Climate change Climate change effects
Christy	Climate change definition Greenhouse gases Why is climate change controversial
Julie	Climate change Climate change concerns Climate change concerns : since 2013* Why are people concerned with climate change
Joan	Climate change How will climate change affect people's lives
Kelly	What is meant by climate change What is the concern about climate change
Leslie	Climate change Climate change cons Climate change consequences Climate change effects Definition of climate change Meaning of climate change What is climate change
Nathan	Climate change Climate change predictions How is CO2 measured in ice Information from ice cores What are the effects of climate change

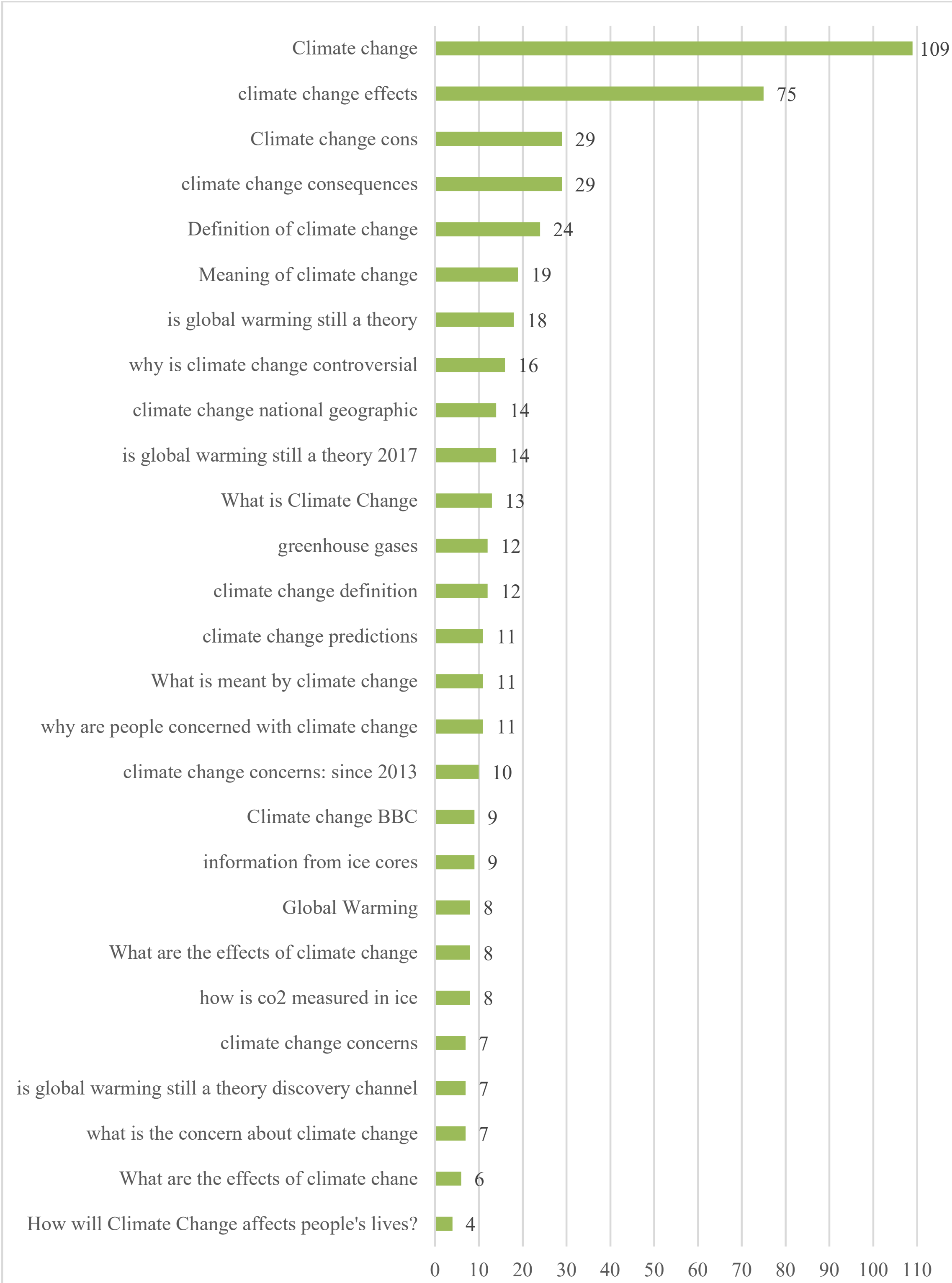

Figure 5. Number of Resource Returned Per Search Terms: Climate Change Search

Resources Used During Searches

In both the fracking and climate change searches, seven of the eight participants used a similar number of search terms. Table 9 displays the number of resources yielded by each participant in the two information searches. This number can be linked to the number of search terms presented in Tables 7 and 8 and can be tied into discussions on the extent to which a participant went in depth into the pages of search results. For instance, Alice, entered fewer fracking search terms (one as indicated in Table 7) compared to climate change search terms (two as indicated in Table 8) to access resources during the two-question computer search portion of her research session yet both searches yielded almost the same number of results. This indicated Alice tended to sort through more pages of her search results than other participants.

In another instance, Addy used two fracking search terms to yield nine possible resources and seven search terms to yield 79 climate change resources. This significant difference is because Addy accessed many search results pages in her climate change search yet stayed on the first page of her fracking search result list. Fewer search terms with higher resource yield was due to participants scrolling through more pages of the search results. Joan showed consistency across both searches as she typed in two and three search terms yielding similar numbers of possible resources in both topics. Others, like Nathan, used greater numbers of search terms, eight for fracking and five for climate change, and accessed 93 and 73 pertinent resources as he opted to reenter different search terms sorting through the first or second pages of his search results.

Table 9. Number of Resources Displayed During Searches

Participant	Fracking Resources	Climate Change Resource
Addy	9	79
Alice	83	81
Christy	12	40
Julie	27	48
Joan	23	20
Kelly	7	18
Leslie	66	141
Nathan	93	73
TOTAL	**320**	**500**

Table 10 provides an overview of the number of resources each participant selected from those displayed. The table also provides an overall picture of the participants' search strategy indicating the number of resources used to respond to each computer question and the percentage of these resources when looking at the total number of resources yielded by the participants' searches. In twelve of the sixteen searches, participants used a quarter or less of the resources made available in their search results.

In the other four searches, which were all conducted during the search for fracking information, Addy (33.3%), Christy (41.7%), Kelly (28.6%), and Nathan (38.7%) accessed a greater percentage of resources they encountered on their search results than Alice, Leslie, Joan, and Julie. Despite this, no participant accessed most of the resources made available to them on the Internet during the fracking and climate change information searches. While participants were exposed to 820 webpages during their fracking and climate change searches, they engaged with 17.3% (142) of the resources. Specifically, participants engaged with 75 fracking resources and 67 climate change resources as shown in Table 10.

Table 10. Number and Percentage of Resources Selected During Searches

Participants	Fracking Resources	Climate Change Resources
Addy	3 (33.3%)	19 (24.1%)
Alice	7 (8.4%)	9 (11.1%)
Christy	5 (41.7%)	6 (15.0%)
Joan	4 (17.4%)	5 (25.0%)
Julie	6 (22.2%)	5 (10.4%)
Kelly	2 (28.6%)	3 (16.7%)
Leslie	12 (18.2%)	6 (4.3%)
Nathan	36 (38.7%)	14 (19.2%)
TOTAL	**75**	**67**

Leslie and Nathan had a different approach as they used more search terms for fracking, six and eight respectively. These two participants also accessed additional pages of the search results rather than remain on the first page of search results. These two participants used the same search term strategy in the climate change search as well. Leslie used seven search terms and Nick used five to yield 141 and 73 resources, respectively. Each time, these two participants accessed more pages of the search results per search term. Alice was an outlier as her strategies differed. She entered two search terms for fracking and scrolled through multiple pages of the search results; thus, accessing 83 resources with two search terms. In total, participants used 27 search terms to access 320 fracking resources and 32 search terms to access 500 climate change resources.

As participants looked through the search results lists, they reacted in one of three ways to resources on the result list. Participants either pass by the resources, paused on the resource but did not select it, or pause on the resource and select the resource. The present study used the video recorded information search files to determine which level of engagement the participants had with the resources yielded in their search results.

To visualize the participants' searches, Table 11 provides details on how their participants' search time was spent as it presents the amount of time participants were engaged with the resources they had selected as opposed to the time spent searching for resources. This percentage was calculated by adding the amount of time the participant spent engaged with the selected resources, tallying this time, and dividing the time by the total search time of the participant. In looking at Table 11, each participant spent a majority of their information search session engaged with (skimming, reading, etc.) the resources they selected. Two participants, Christy and Joan, spent almost 92% of their time engaged with resources they had selected.

Table 11. Percent of Search Time Engaged with Opened Resources

Participant	Fracking Resource Engagement	Climate Change Resource Engagement
Addy	81.8%	84.9%
Alice	58.9%	74.2%
Christy	89.0%	91.8%
Joan	88.7%	91.8%
Julie	64.6%	60.0%
Kelly	86.5%	88.0%
Leslie	70.5%	65.3%
Nathan	80.3%	68.6%

Findings Related to Research Question One: How do non-science experts define credible science information?

In Hilligoss and Rieh's (2008) Unifying Framework of Credibility Assessment Model, one's definition of "credibility" was said to be personal and complex. This framework implied one's definition of credibility impacted the evaluation and synthesis of information one encountered. Defining "credible science information" is no different. The present studied applied the Hilligoss and Rieh (2008) framework to acknowledge the uniqueness in which the participants define credible science information and to determine how these participants, or non-science experts, defined credible science information.

Participants Define Credible Science Information

Data generated from the eight stimulated recall interview transcripts identified constructs and rationales used by the participants to define credible science information found online. The following section is subdivided by each participant (Addy, Alice, Christy, Julie, Joan, Kelly, Leslie, and Nathan) and presents their individual definition of credible science information. Through the study's findings, a range of constructs used to define credible science information emerged. Important to note is each participant identified multiple constructs.

Figure 6, depicted below, was created through the use of Wordle, an Internet-based software used to generate word clouds of commonly used words in a document. After listing out all constructs indicated by the eight participants during their follow-on interview, the Wordle presented in Figure 6 was created to visually depicts the constructs and the number of times each construct was identified by the participants while discussing *credible science information*. The larger more prominent text indicates constructs mentioned more often. Smaller text indicates constructs mentioned less often. From this word cloud presented in Figure 6, *unbiased* seemed to be the most common defining construct. Constructs ranged from descriptive (i.e. fact-based) expectations of credible science-based information to prescriptive (i.e. accuracy) characterizations of how the participants gauge credible science information based on its usefulness.

Figure 6. A Visual Depiction of *Credible Science Information* Definition.

Addy. Addy placed significant credibility value on resources and agencies she had used throughout her lifetime. For instance, she had a typical search strategy of looking for information on British Broadcasting Channel (BBC) and National Geographic as both sources were considered credible to her because she has built a trust in them over the years, thus the information they provided was deemed credible. When speaking of National Geographic, Addy stated she “feels that’s the most trusted site” since the agency “will continue to report factually and fairly on how climate change is altering the earth” and the webpage “has a lot of visual interests and engages [her]” and she “would hope that they’re nonpartisan.”

Addy defined credible information as "reliable" and stated she avoided user-generated sites like Wikipedia as "anybody can write into it and write the definitions into it or whatever they want to…so, it's not always reliable." Lastly, she identified accuracy and dependability as ways in which she defines credible science-based information as "you need to make sure you check the accuracy" as she sought and valued dependable information.

Alice. Indicated credible information comes from a recognizable company or a reputable name and she typically avoided webpages with which she had no prior experience, such as Investopedia.com, or which contain "strong opinions, such as YouAskGoogle. However, Alice used Wikipedia, a user-generated webpage as background. She vetted this user-generated content against other non user-generated webpages.

Alice stated that credible information lacks bias and she determines the presence of bias though the words used throughout the resource. For instance, words such as "safely" and "gradually" alert her to a non-credible source when reading information on fracking as she does not believe fracking to be safe or the process to be gradual. Alice identified credible science information as being "middle of the road" with no lean in support of or in opposition of the topic. Lastly, Alice identified "trust" as important in defining credible science information as she quickly navigated away from a webpage with a political advertisement pop up which interrupted her reading.

Christy. A high school English teacher, Christy's definition of credible information kept referencing the notions of being "unbiased," "trustworthy," and "straightforward" and "comprehensive." When asked to describe what she meant by these terms, Christy stated that unbiased science information was "informative rather than persuasive" and lacked opinions. Christy also discussed sponsorship of information impacting her perception of information credibility because of perceived bias. This came to light when discussing fracking resources as she stated that "the industry-funded body, being the major proponent of bringing fracking to the U.K., again, not to repeat terms, but that seems to me that could have a bias."

As for language, if persuasive text, later defined as "loaded language" were detected, the participant deemed the science information not credible and she navigated away from the resource. Christy stated that "I'm looking for a lack of [loaded language]. I'm looking for, I don't want to see 'always' and 'never' statements." Another construct Christy used to define credible science information was the term "straightforward." When asked to explain, Christy said that straightforward information was credible because "a straightforward definition, it feels trustworthy, generally, or as trustworthy as anything can be online." She stated that "credible science information was information that's communicated in a straightforward way, that has evidence and the process by which that evidence was obtained." Credible science information was "comprehensive" when it covered the full story and presented evidence that "research has gone into it and it's been vetted by several steps in that process."

Julie. The youngest participant, Julie graduated a few years back and referenced professors several times as those helping or haunting her to make good decisions regarding credible online resources. Through her search and stimulated recall interview, Julie seemed to define credible science information as resources affiliated with scholarly sites, such as Google Scholar, not associated with user-generated websites, such as Wikipedia, available on specific domains, and lacking ad affiliation. While other participants would access or seek out Wikipedia as a source, Julie avoided all entries denoting a Wikipedia address as she did not think user generated content would be credible information. Julie seemed to search out specific domains as being more credible over others. For instance, she selected a resource with a .org domain and then supported her decision indicating the resource web address “said .org and that feels more official than a .com” resource. She also sought .edu domains as being credible and later expanded credible domains when she said “it’s .gov, .edu, and .org – all of them feel more official than .com.”

Joan. The information level of credible information was important for Joan as she wanted credible resources which “were interesting” and provided information “in fairly simple terms.” She “always liked public radio and public broadcasting” and values those sources to be credible. According to Joan, credible information is “fairly straightforward. It’s fairly simple, and it’s very concise. It’s something that [she] can understand and it’s answering [her] question.” Lastly, Joan stated credible information is unbiased and is science information discussed by credible sources.

Kelly. Kelly approached this search as she would a casual information search at home. She focused on answering the questions presented on the computer answer sheet. Credible information is information easy to understand and “straightforward.” Kelly wanted credible information to be easy to use so she would not have to dig or scroll through webpages for it. Nor did she want information “buried in the statistics” for casual information searches. Kelly indicated she “really didn’t give it a thought to what page [she] was on, because it had the information that [she] was looking for.”

Leslie. During Leslie’s stimulated recall interview, she emphasized that credible science information had to be “simple”, fact-based, and current. She described credible information as information “broken down for somebody who has no idea what they’re looking for" and lacking "a ton of large words that I'd never know in my life." She defined *simple*, to mean "it's not a bunch of scientific terms that the average human being has no idea of what they are doing." Leslie also defined credible science information as lacking opinions as "it was actual resource material versus somebody bashing it in a blog." As she felt blogs were "somebody ranting versus educational facts."

Leslie accepted user-generated as credible as she said "it seems good enough for me…. I know people can edit it and put whatever they want to, but I would hope there is good in the world that they wouldn't put a whole bunch of frivolous facts out." Leslie echoed other participants defining characteristics stating credible science information should present comprehensive information on the subject matter and "talk about [climate change] as a whole." Lastly, Leslie thought credible science information should be current to incorporate any science and technological advances.

Nathan. Acknowledging the controversial nature of both topics he was asked to search during the computer information search portion, Nathan initiated his definitions of credible science information as lacking a bias and he indicated searching for online resources which have gone "through the rigor of putting sites and putting facts." He likewise went on to say credible information should be fact-based and lack opinions as he "was just looking for facts" and wants to "build opinions and build conclusions based on facts."

In his search for credible information, the idea of controversial was on his mind as he "distrusts sites which look nice" or "fancy websites" as he feels "[the sponsoring agency has] gone to the effort of spending a lot of time trying to make it look nice then they're probably focused on something other than the actual information." Pointing to a site, he explained “this site isn’t going to tell me anything because they’re just going to say its’ all nice and peachy.” He avoided resources appearing as if they were seeking to increase readership or catch his attention. His examples of these resources were those webpages associated with advertisements. Lastly, Nathan considered scientific papers or resources as credible information when they provided links to other sources or referenced articles. These resources were classified as credible because they provided the path of information and discernible facts. As presented in this section, the research participants held a range of definitions credible science information. In the next section, findings pertinent to the second research question are presented.

Constructs across the cases. Participants identified a variety defining characteristics in their selection of constructs and in the number of constructs used to define credible science information. Many of the constructs identified by the participants defined characteristics of credible science information through their perception of the information or the resource being useable and understandable. References made to a resource’s “strong language” or the inclusion of “never” and “always” statements on a webpage led some participants to perceive the information or the webpage as not credible. Other references to information being “simple,” “straightforward,” or being provided in “layman’s terms” illustrates participants wanting credible information to be understandable on an individualistic level. However, information perceived as too basic or “too elementary” was off-putting to several participants as the information was then considered “nuanced” or void of hard facts intended to avoid upsetting younger minds.

The three most common attributes identified when defining credible science information was 1) credible information was repeated on various websites and resources, 2) information was current, and 3) the information lacked bias. While most participants did not look at the sources of each webpage or resource, they mentioned searching for similar facts on various websites or checking facts against various pages. Several participants made note of wanting current information, and although each shared the same basic rationale in why resource should be contemporary, "current" was not consistently defined in a set number of year across those participants identifying publication date as important.

Other constructs to define credible science information included *fact-based*, *trustworthy*, *lacks opinion*, and *simple.* Nathan, Alice, Christy, and Leslie stated that credible science-based information was fact-based while three participants used trustworthy, lacks opinion, and simple. Four additional constructs emerged and were indicated by one or two participants. These constructs include reliable (Julie), comprehensive (Christy), accurate (Christy and Addy), and reasonable (Joan). In total, the participants used a combination of defining characteristics when asked to identify credible science information, whether it be two constructs or eight. As Table 12, below displays, Christy identified eight constructs to define credible information, Alice provided six, Joan and Nathan utilized five constructs, Leslie and Addy identified four constructs, and Julie and Kelly provided two constructs. All participants used multiple constructs to define credible science information.

Table 12. Common Defining Constructs of *Credible Science Information*.

Construct(s)	Participants
Repeated Information	Addy, Alice, Joan, Julie, Leslie
Recently Dated Information	Addy, Alice, Christy, Joan, Nathan
Lacks Bias	Addy, Alice, Christy, Joan, Nathan
Straightforward	Christy, Joan, Kelly, Nathan
Fact-based	Alice, Christy, Leslie, Nathan
Trustworthy	Alice, Christy, Julie
Lacks Opinion	Christy, Leslie, Nathan
Simple	Alice, Leslie, and Kelly
Accurate	Addy, Christy
Comprehensive	Joan
Reasonable	Christy

Findings Related to Research Question Two: What General Rules and Cues do Participants Use to Select Credible Science-based Websites During an Online Search?

In this section, findings relevant to the second research question are discussed. This research question was focused on the heuristic level presented in the Hilligoss and Rieh (2008) Unifying Framework of Credibility Assessment. Heuristics are general rules which participants utilize as they explore online resources and these rules seem to stem from the participants' perceptions, prior experiences, and interpretations of how the online information is presented. Five salient themes, presented in Table 13, emerged in support of this research question pertain to the general rules which participants followed when selecting websites which contained credible science-based resources. Figure 7 presents a concept map of the research question and the links to the four themes and supporting thematic divisions. The following section further identifies these themes and findings.

Table 13. Themes Relevant to Research Question Two

Theme	**Description**
Theme 1	Text presented in the search result list impacts selection potential.
Theme 2	The search result order impacts selection potential.
Theme 3	Advertisement icon by search result deters selection.
Theme 4	Prior experience with source/sponsoring agency impacts selection.
Theme 5	Secondhand experiences influence credible science resource selection.

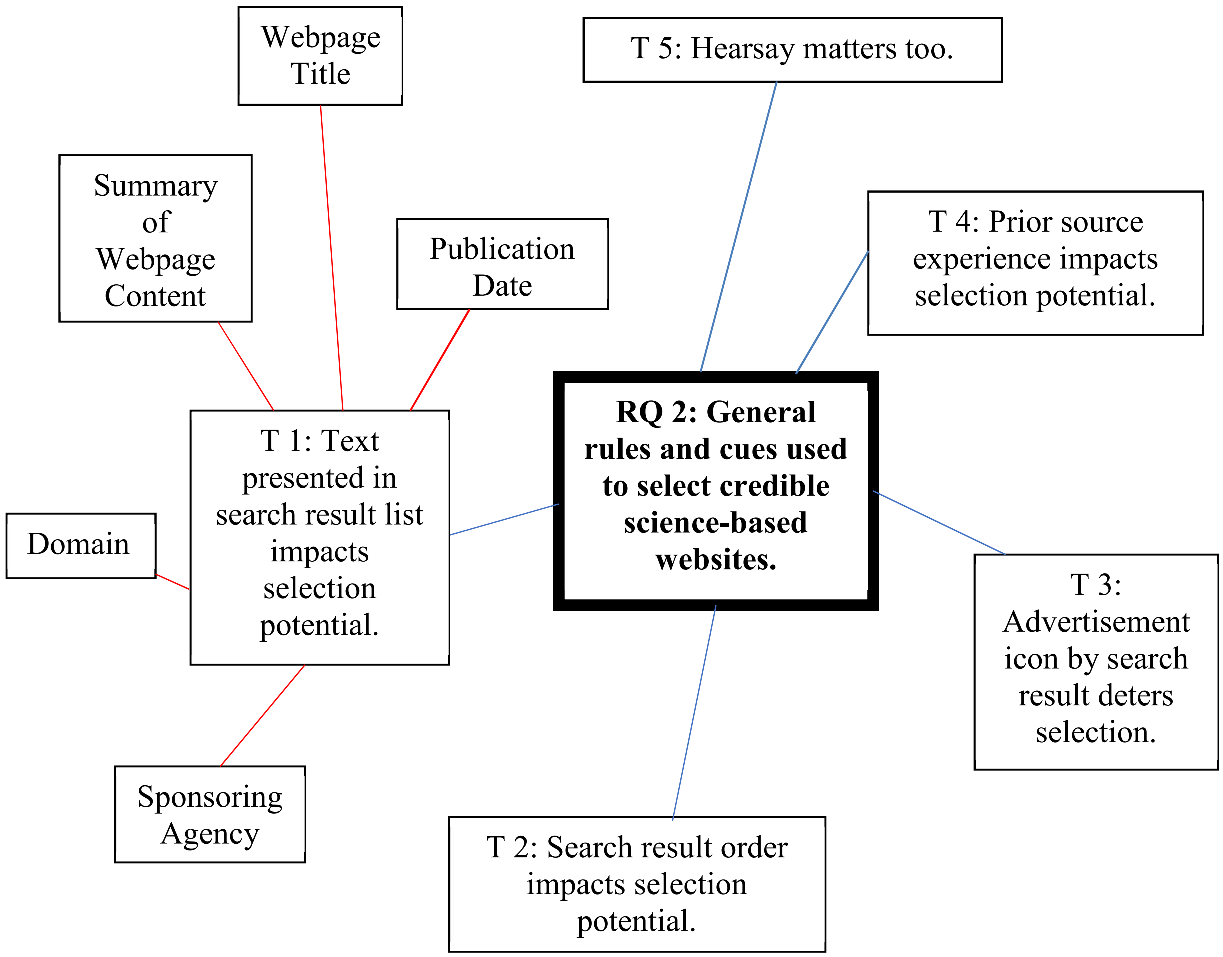

Figure 7. Concept Map of Research Question Two and Themes.

Theme 1: Text Presented in Search Result List Impacts Selection Potential

Participants in this study inferred credibility of web-based resources from the few lines of text appearing in each entry of the search result lists. When search terms were entered in the search engine, the search engine populated a result list comprised of webpages it had identified as having those specific search terms. The search result lists seemed to be similar in style irrelevant of the search engine and web browser software used. The typical search result list format includes a larger text size *webpage title*, or header, which can, but not always, include identification of the sponsoring agency. Below this title, is a webpage address which can, but not always, identify the *sponsoring agency* and *domain*. This second line is typically where advertisement affiliation is located should websites have financial means to promote their content. The third line of search result entries often begins a *publication date* followed by the *summary of the webpage* which can be one to several lines in length. An important observation is the publication date is not present in all entries, it appears mainly for news and media resources. The following section further discusses these text components and how or if the components were identified by participants. To maintain consistency with the search result entries, the text components are discussed as they appear in the search result entries (webpage title, sponsoring agency, domain, publication date, and summary of the webpage,).

Webpage title. Website titles presented in the search result list was found to have an impact on credibility judgments. Five participants (Alice, Joan, Julie, Kelly, and Nathan) chose websites with relevant titles and summaries. If the website title indicated it was a blog or user-generated website such as Wikipedia, five participants (Addy, Alice, Julie, Leslie, and Nathan) indicated website to not be credible, even though two of these participants (Addy and Nathan) admittedly used Wikipedia for "inspiration" and to provide "direction" in their searches. Alice indicated she looks for a reputable name in the title and she makes judgements on terms presented in the title. For instance, a resource provided "environmental council" in the title and Alice "knew that it is was an environmental council, then they would likely list out concerns" regarding the process of fracking.

Kelly selected a resource she was unfamiliar with known as the Pew Research Center because the webpage summary indicated the resource would provide seven charts. Kelly mentioned her rationale in selecting this resource. She "figured that it would give [her] more information. Nathan would read through the search results list. He stated he read "mainly the highlighted links" to determine which resources he wanted to open. Nathan used the webpage titles to determine relevance and admitted to not selected websites because of titles he did not find credible. One such site had the source, *Daily Caller*, denoted in the title. Nathan immediately avoided the webpage due to his perception of the reputation of the source. Lastly, Julie found relevance in the webpage titles she read when scrolling down through the search results. She indicated she would read through these quickly to search for any key words which caught her attention regarding her search interests.

Sponsoring agency. Five participants specifically identified reputation of a website's sponsoring agency as being critical in their decision to access the site. From this, it was noted that sponsor perception impacted selectivity of resources when looking for a credible science-based website. Alice Addy, Julie Joan, and Christy stated they would typically select webpages if they recognized sources or agencies. Alice noted she would not select a webpage if she was unfamiliar with a particular resource. An example of an unfamiliar resource was Investopedia.com and Alice pointed out she avoided that resource when it came up in the search results because she was not familiar with the webpage's sponsor. Addy allowed familiarity with sponsoring agency to impact selectivity as she bypassed skepticalscience.com due to "concern about going to that. I don't know who's governing that…" As she continued to scroll through resources, she admits being drawn to select resources by Forbes and National Oceanic and Atmospheric Administration (NOAA) because of her familiarity with these agencies.

Christy sought reputable webpage sponsors such as *Popular Mechanics* and the National Weather Service (NWS) during her credible information search. She had not used either source previously in an online learning episode but had valued prior experience with each agency in a different media. In explaining her *Popular Mechanics'* selection, Christy stated, “I typically try to look for a current article from a reputable source because particularly, it seems like with science…. like things can change so quickly.”

Domain, if displayed. Website domain surfaced as an indicator of credibility, but this component of a webpage is not always presented as part of the search result. Three participants (Christy, Addy, and Julie) identified their evaluation of .gov websites as credible. Christy stated she had selected the Environmental Protection Agency (EPA.gov) webpage “because it was a government website and [she] thought would have arguably more informative information as opposed to again, persuasive information.”

Two participants (Addy and Julie) reported .com websites were not credible and certain .org websites were not credible. Julie reported she evaluated most .edu websites as being credible based on her collegiate education as many professors would accept .edu websites on bibliography assignments, but not other domains. In fact, she stated, “usually though when I'm trying to do stuff like this, I'll go if it says like.edu or something like education based, it feels right.” In talking about other domains, Julie also noted her preference in selecting .org resources over those indicating .com affiliation as “it said .org and that feels more official than a .com.”

Addy stated she was “going to skim down looking for resources that are probably government, .gov, or .orgs” as these are typically the most reliable resources. She later stated that .gov sites “provide a wealth of information of what you need” based on her interactions with the Internal Revenue Service (IRS) webpage and the CDC webpage. She associated .orgs with nonprofits and said she uses those with caution as some are not “good.” However, she noted that if she is unfamiliar with a .org, she double checks the information she retrieves from a new site against other information she has found.

The following paragraphs discuss the figures depicting the domain breakdown of the resources encountered by participants during the computer search session. Segments of the pie charts labeled as “NI” represent resources in which the domain was “not indicated” in the search result entry. In Figure 8, the domains of resources encountered during the fracking information search are presented. Over half, 51%, of webpages listed on the search results for fracking resources were from .com domains. Examples of .com domains include the British Broadcasting Company (BBC), National Geographic, Popular Mechanics, Forbes, CNBC, YouTube, Investopedia, and various non-sponsored sites along with webpages sponsored by companies affiliated with the oil and gas industry. Over a quarter, 26%, of the webpage were from .org domains which include sponsors such as Wikipedia and National Public Radio (NPR). Several resources in the search result list did not present a domain in the search results list and are represented by the pie segment labeled NI as there was no domain indicated. Examples of these search result entries included the definition box. The definition box was selected by many participants as their initial definition provider for fracking or climate change and scholarly article domains listed on GoogleScholar.com. Lastly, pie chart segment presenting <1% had actual resource values of 1 resource and 2 resources, fracking and climate change, respectively.

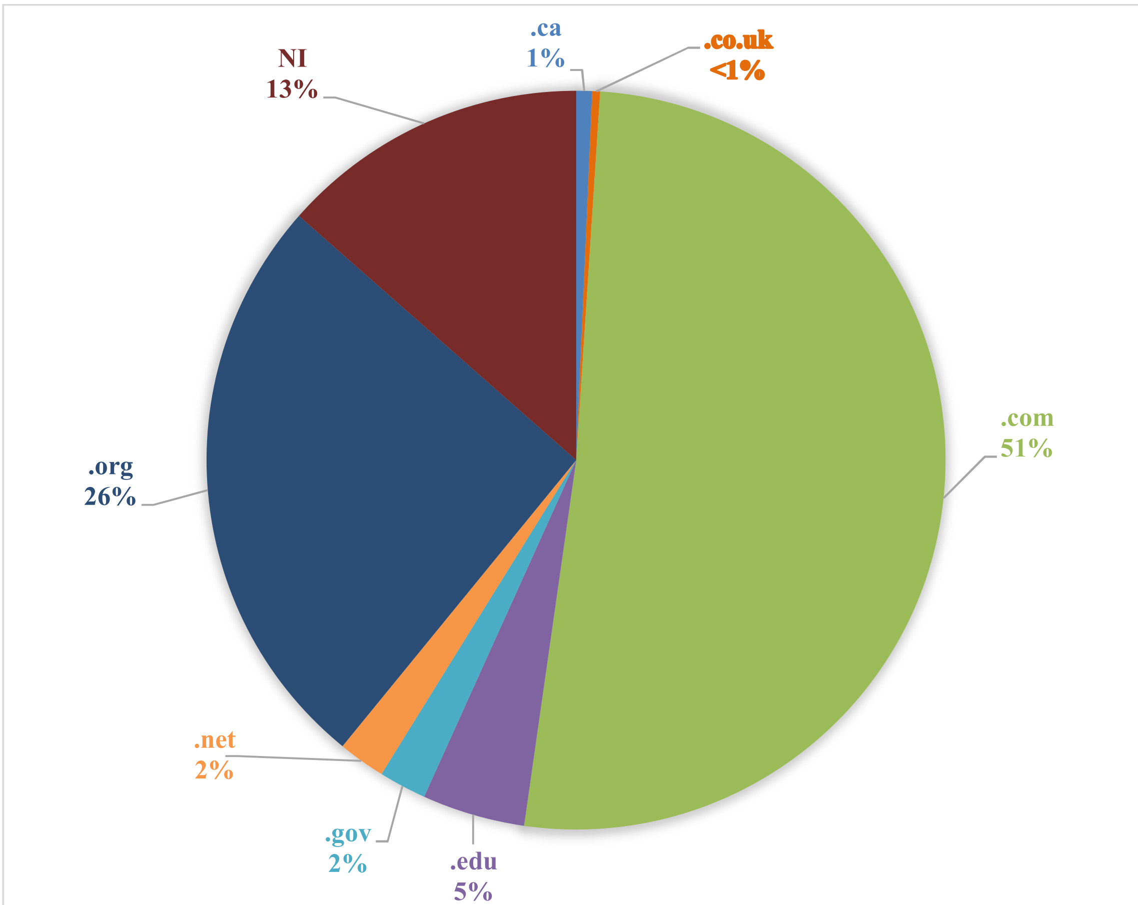

Figure 8. Domains of Fracking Resources Identified in the Search Results.

Figure 9 displays the domain breakdown of the climate change resources yielded in the participants' search result lists. Again, a substantial portion, 38% of climate change webpages resulted from .com domains and the second largest percentage was .org domains with 22% of webpages. Those domains indicating <1% (.UK, .info, and .gov.uk) had actual numerical values of 2 resources from each of those domains.

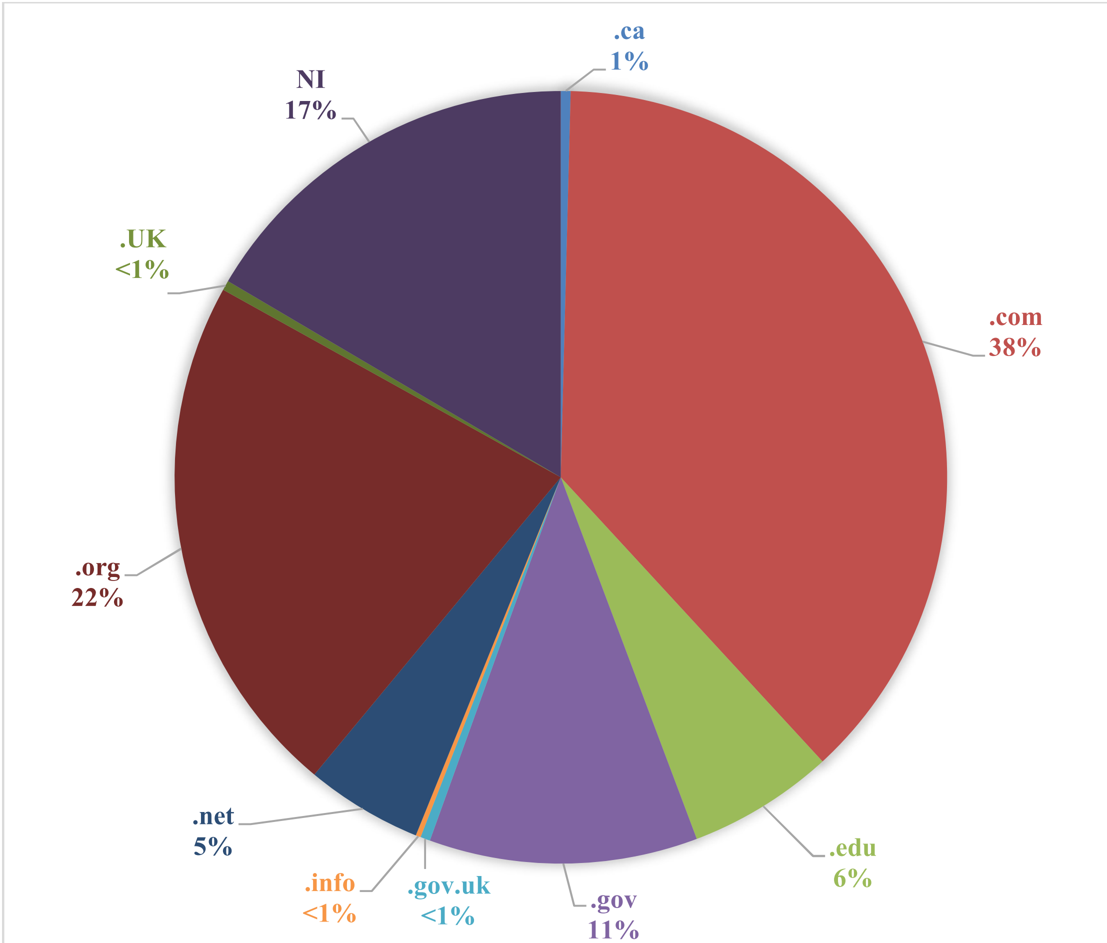

Figure 9. Domains of Climate Change Resources Identified in the Search Results.

Selected webpage domains. The following figures display the breakdown of fracking and climate change webpages further classified out by how the participants selected to engage with the webpage as it was presented in the search result list. Figure 10 and Figure 11 detail domains of the webpages selected by the participants during their information searches for credible fracking and climate change information.

As shown in Figure 10 and Figure 11, most of the resources participants engaged with for fracking information and climate change information were located on .com websites. The most commonly selected fracking resources with .com domains were BBC (12%), National Geographic (5.3%), Popular Mechanics (4%), and NPR (4%). There were many .com sites accessed only once during the research. The most commonly selected domain for climate change resources were .com sites. As with fracking resources, access to resources varied. There were many climate change resources accessed one time, but several resources accessed repetitively. The most commonly .com websites selected include *National Geographic* (11.9%), BBC (7.5%), and Forbes (4.5%).

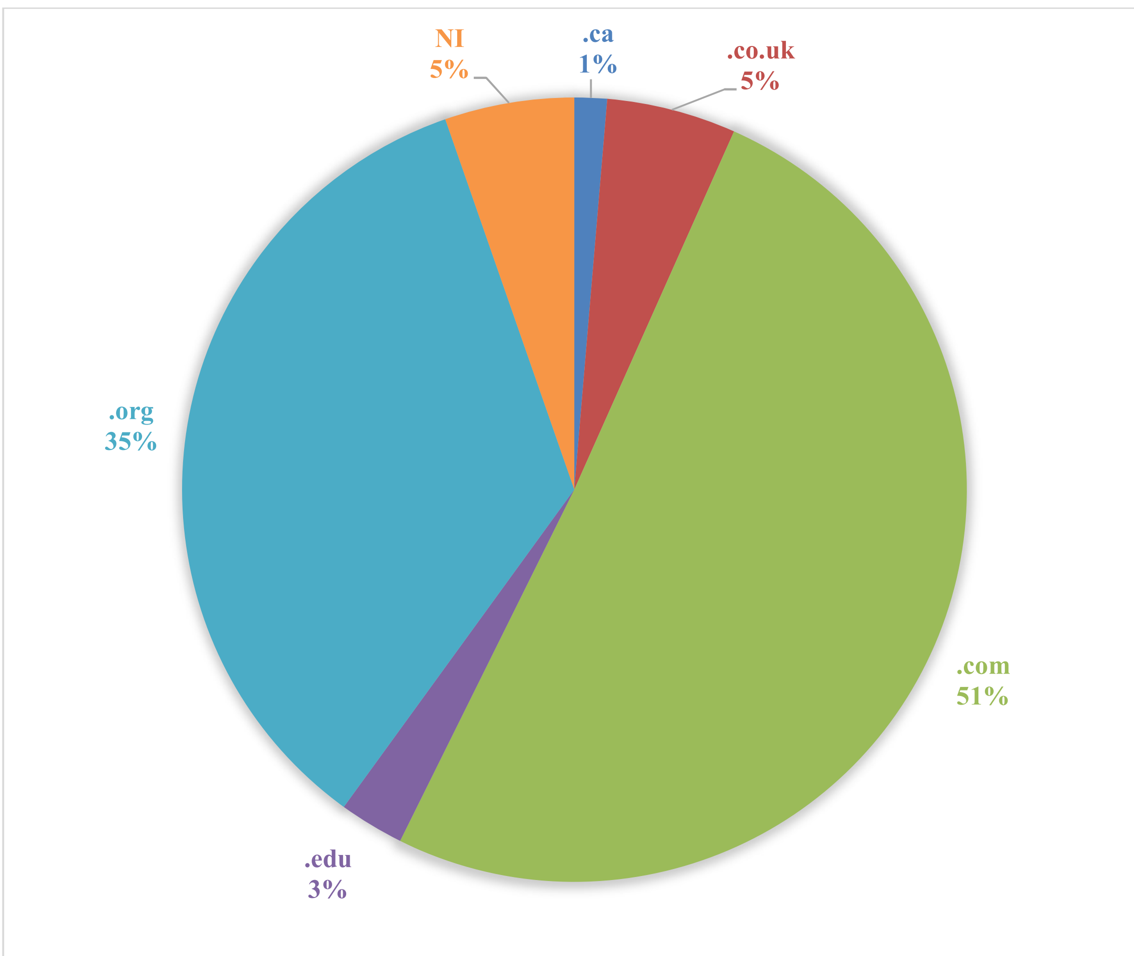

Figure 10. Domains of 75 Fracking Resources Selected

The second most common domain for fracking information yielded 35% of the resources which the participants accessed stemmed from .org domains (Wikipedia with 16% and EnergyfromShale.org with 14.7%) and the second most common domain for climate change information was .gov and included resources from NASA (17.9%), EPA (4.5%), and NOAA (4.5%). Participants also selected a large portion of climate change resources from .org domains primarily due to their use of one resource, Wikipedia (7.5%).

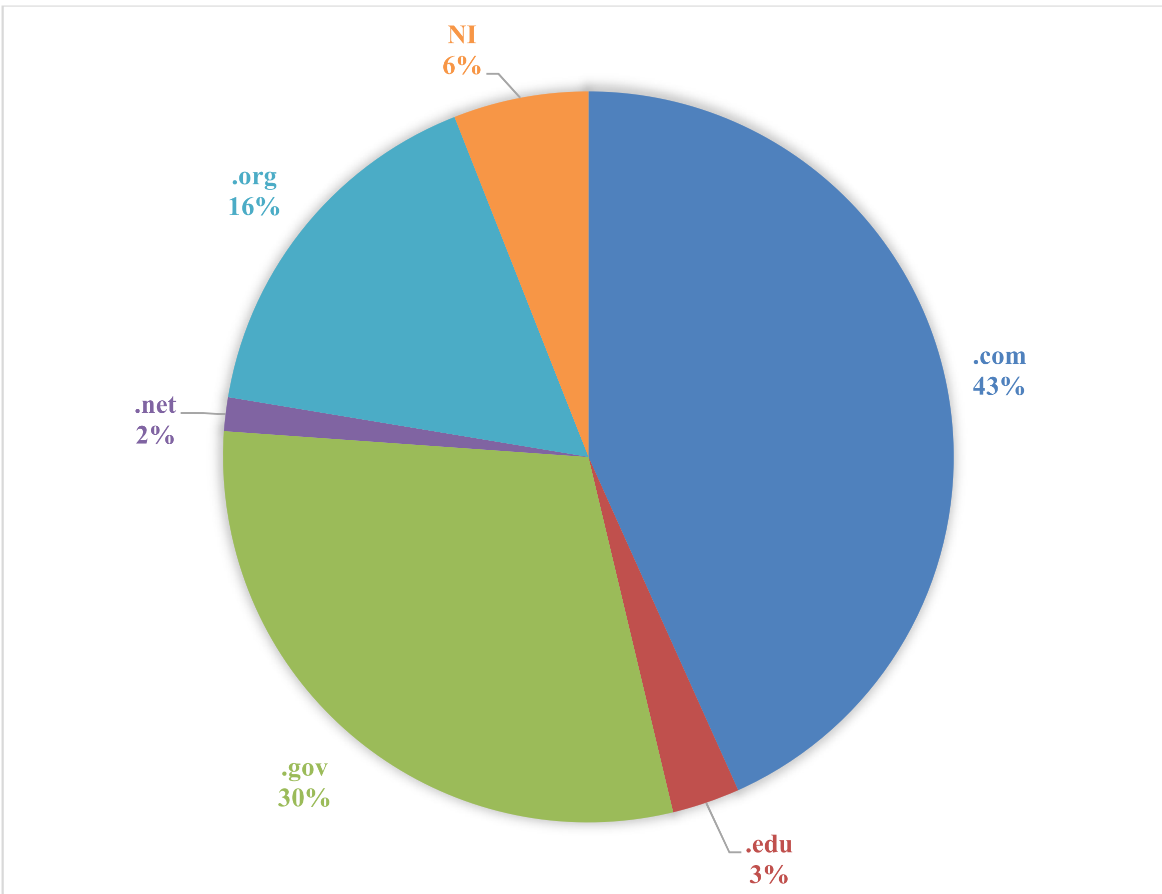

Figure 11. Domains of 67 Climate Change Resources Selected

Paused on, but not accessed webpage domains. Figure 12 and Figure 13 display the domain breakdown of the webpages participants paused on but did not select to use during their online search sessions. Domains of each category are provided and resources lacking domain identification on the search results page are clumped into one category labeled as NI." These resources shown in Figure 12 detail the domains of the 30 fracking resources participants passed by and the graph indicates that over half of these resources had .com domains.

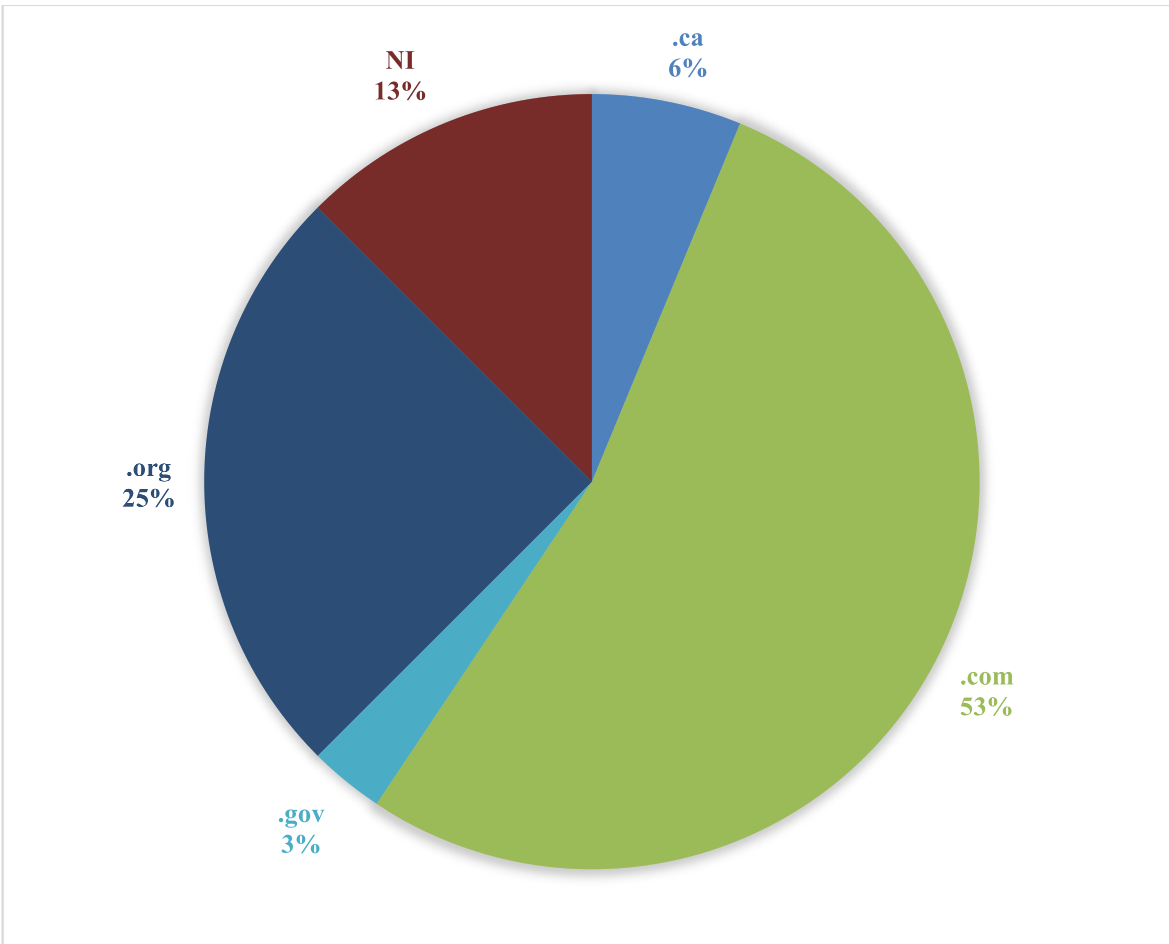

Figure 12. Domains of 30 Fracking Resources Paused on But Not Selected

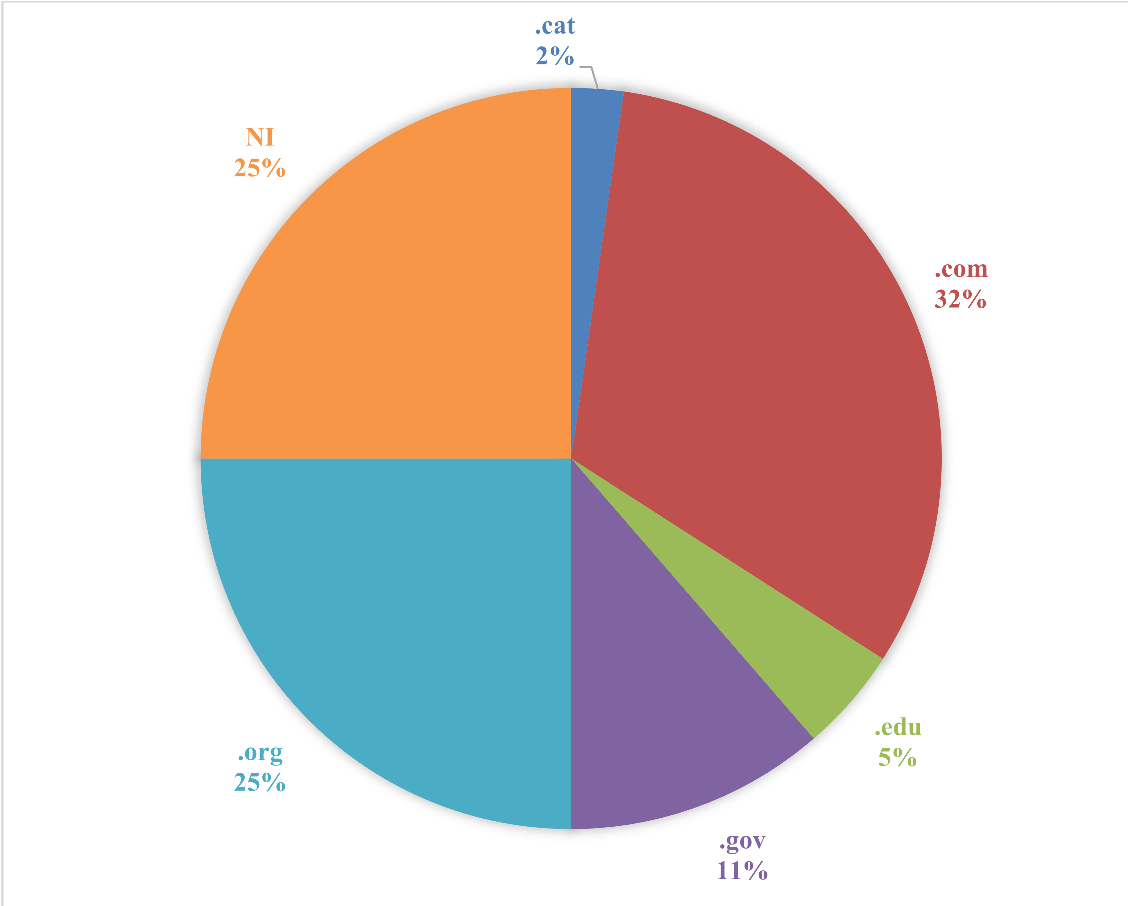

Figure 13. Domains of 47 Climate Change Resources Paused on But Not Selected

Figure 13 details the resources which participants paused on when looking for credible climate change information and the findings show three equally distributed domains which caused participants to pause. These domains were .com, .org, and NI. Most of the NI resources represented in Figures 12 and 13 represent articles displayed on GoogleScholar.com. Resources on the GoogleScholar.com webpages did not have a domain listed in the search result list, rather the domains for these resources can be identified once the resources is selected. Since these resources were not accessed during the participants' searches, the domains were assumed to not have played a pivotal role in the resource selection.

Passed by and not accessed webpage domains. *P*articipants passed resources during the credible information search for fracking and climate change resources. These resources were not paused on nor selected when initially viewed in the search result list. Figure 14 represents webpages listed out on the search result pages and passed over during the fracking information search. Of the 215 fracking resources passed by during the participants' search, 96 of the resources, or 44.7%, were housed on a .com domains. Again, most of the webpage resources represented by NI are from sources passed over on GoogleScholar.com during Alice, Julie and Leslie's information searches. This webpage does not always indicate a resource's domain in the search result list.

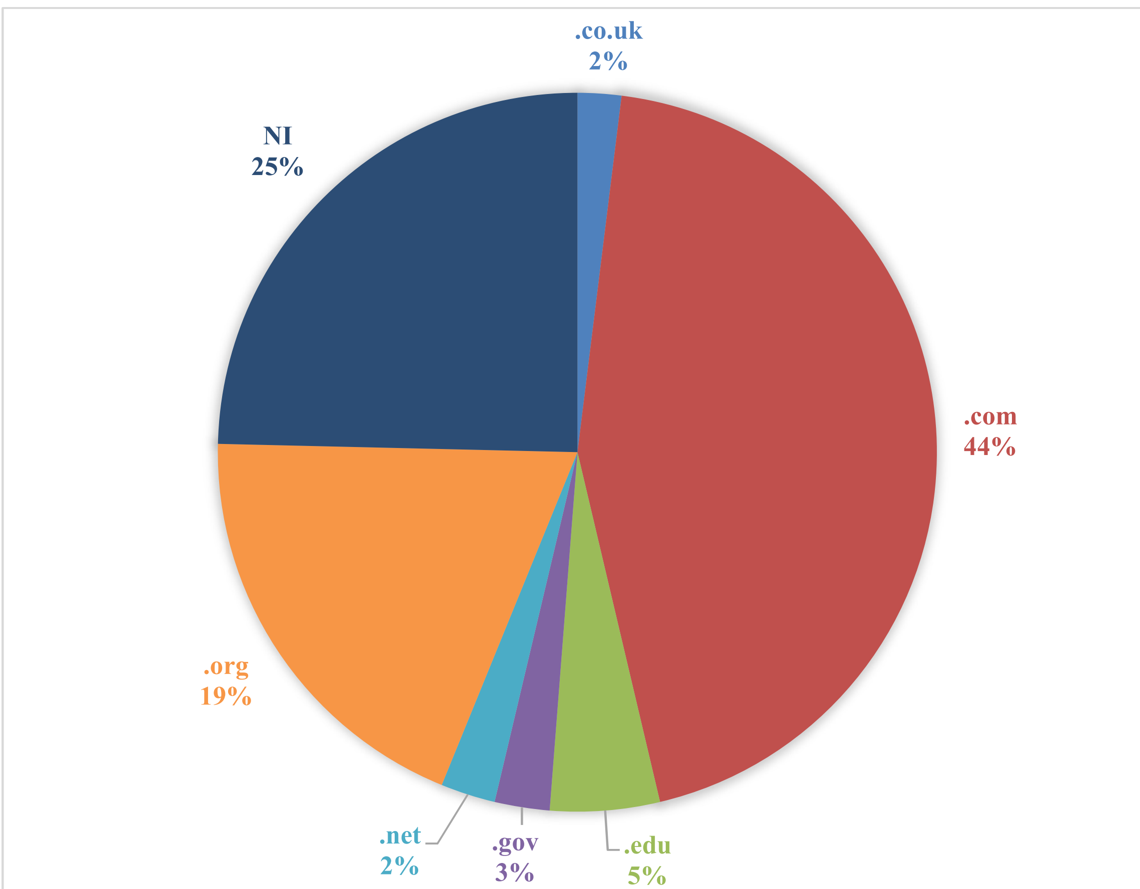

Figure 14. Domains of 215 Fracking Resources Passed By

Figure 15 provides the domains of webpages passed by during the participants' climate change information search. In searches for climate change information, 142 of the 386 resources, or 37.8%, participants passed over were attributed to .com websites. Climate change resources from .org domains (87 resources or 22.5%) were also passed over by participants. As with the fracking resources, those representing the NI section of the pie chart (72 resources) are predominantly from GoogleScholar.com and did not identify a domain in their search result lists.

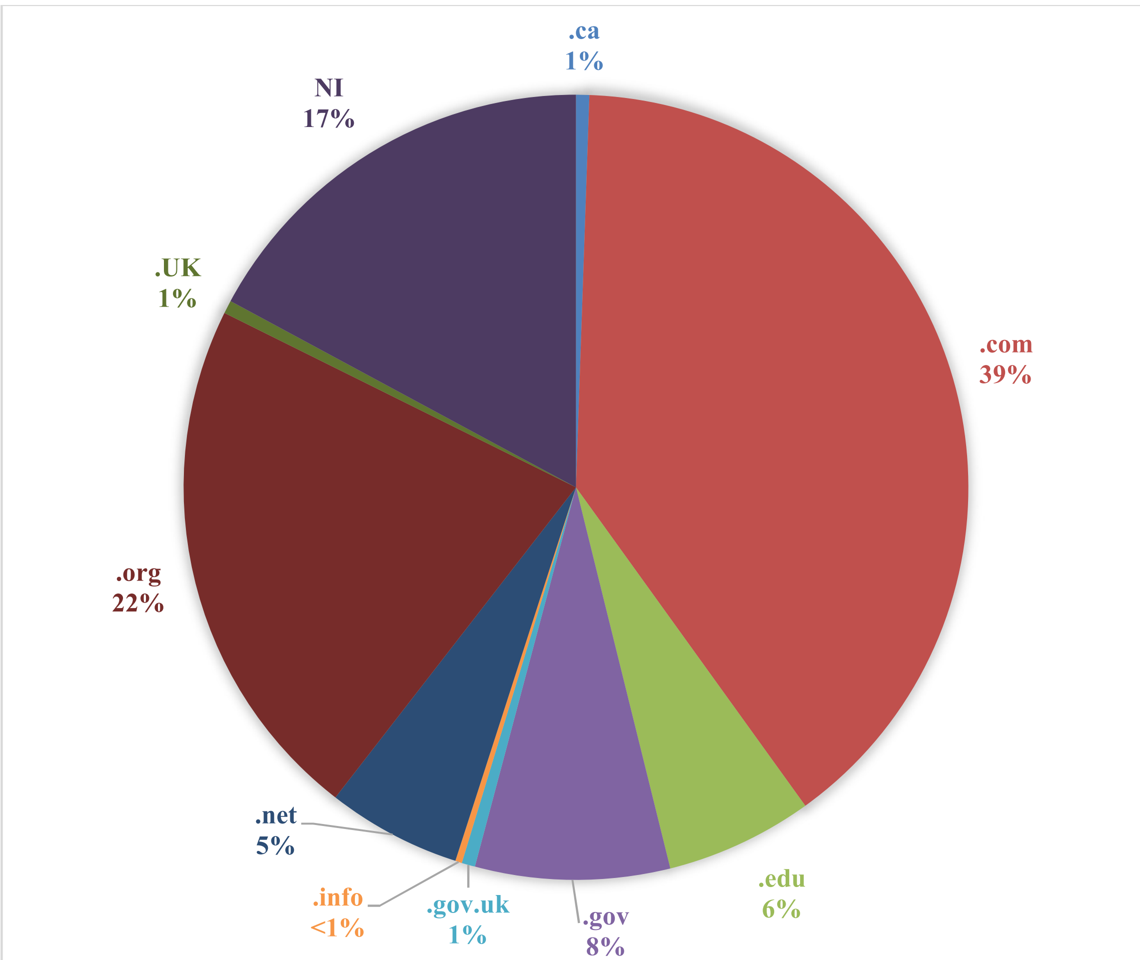

Figure 15. Domains of 386 Climate Change Resources Passed By

Summary of webpage contents. Participants placed value in the webpage summaries presented in the search result lists when making decisions on which credible webpage to select. Christy was looking through the search summaries "for which resource [she] thought seemed to be the clearest definition" for the search term she had used. Leslie skimmed over the summaries as she indicated that "I just kinda took a peek reading all of the different [summaries]." Nathan indicated he "looked at a whole of [resources] whichever one seemed interesting and which one seemed pertinent to what I was trying to figure out." Joan also indicated that she read through the summaries of the search results to see her resource options.

Summaries helped participants determine which sites might not be considered credible. Alice, Joan, and Christy noted sites with "environmental" terms in summaries relayed a bias against fracking. Alice rationalized the webpage with environmental terms in the summary would be "consistent with what an environmental group would want to talk about, which is why are we worried about fracking." Joan said this type of page "would already have a negative focus on fracking due to the environment." Christy added to notion of biased summaries from the text presented. She read "big oil" in a summary which relayed a biasness of the resource in favor or fracking.

Publication date, if present. Many resources did not indicate a date in the search result list or on the resource once it was selected and opened. However, several participants indicated the importance of using current resources as dated webpages might not be credible or contain credible information. Of the participants mentioning publication date being a factor of credibility, the range of time varied in their classification of "dated material."

Joan evaluated the date on resources and stated she is ‘looking at what’s current” over the last year. When encountering a resource dated 2013, Joan exclaimed, “Whoa, 2013? No. that’s way….I’d like something more, at least somewhat more current.” Others wanted more current resources. Alice indicated “[she] noticed it was 2015, so it’s old.” Addy also noted lack of interest in accessing items published prior to 2015 as they were old. She stated credible science information should be no older than” a year and a half to two years.” Leslie also referenced publication date as a link to defining credible science information. She stated that many resources she encountered were old as they were published in 2007, 2008, and 2009. She did find this age of information as up to date given the ever-changing content areas of science and technology. Leslie went on to state that in order for her “to read something published ten to fifteen, etc., years ago, I feel that it’s not as updated information, as we are in the 2017.”

Theme 2: A Webpage’s Placement in the Search Result Order Impacts Selection

The search engine used in an online search utilizes an algorithm to determine which results are displayed and the order in which the results are displayed. Order of resulting webpages seems to impact credibility considerations and selectivity as many participants indicated a preference in selecting the resources close to the top of the result list. Nathan stated he “didn’t scroll much off but stayed on mainly the first page of Google. I didn’t scroll much off of that and look somewhere other than some of the first links that were out there.”

In her fracking search, Leslie was trying to get a better understanding of the process and typed in “shale rock” as this term had been mentioned in her information search as a rock involved in the fracking process. In selecting credible resources to learn more on shale rock, Leslie selected the first resources listed in the search result list.

When asked about the search term and her selection process during the stimulated recall interview, Leslie said “I just typed in shale and it was the first thing that popped up.” Another participant eluded to selecting credible resources that ‘pop up.” Alice stated she looks “for a more reputable name first off and that’s where my eye tends to go” but she also uses the first few resources that “popped up” in the search result list.

Theme 3: Affiliation with Advertisements Deters Selection

Advertisements seemed to deter participants from a resource; in fact, endorsements for websites seemed to diminish the credibility status of websites. Nathan, Alice, Joan, Leslie, Julie, and Christy indicated they had avoided all websites connected to any level of advertisement. Each participant indicated thoughts of websites linked to ads being considered as not credible or not trustworthy given this financial endorsement. Nathan mentioned certain news outlets like FOX and CNN are “plagued with advertisements” which makes it hard to know if the information they post online is real or fake. When scrolling through the search results, Alice indicated avoiding websites like Reference.com and About.com because they displayed small square green “AD” icons beside their search result entry. She noted that she did not select either entry because “I don’t like to click on ads.” Later, in Alice’s stimulated recall interview, she mentioned skipping over the top few search results which were linked to advertisements. She questioned the credibility of these top ranked resources and stated they were listed in the top results because they paid to be promoted.

Theme 4: Prior Experience with Source/Sponsoring Agency Impacts Website Selection

Participants allowed past individual experiences and memories to impact how they reacted to science-based websites. Julie indicated an avoidance for Wikipedia due to collegiate experiences where point deductions were issued for using this as a source. On the other hand, Addy is drawn to websites like *National Geographic* due to fond childhood memories of a beautiful magazine and to the National Oceanic and Atmospheric Administration (NOAA) webpage due to the weather forecasting they provided when she lived in New Orleans fifteen years ago. Nathan is drawn to the British Broadcasting (BBC) since he lived overseas and had positive experiences with the resource when living abroad, yet Christy would not access the BBC since she did not see relevance to access a foreign resource on these particular topics. Addy, on the other hand, stated "BBC is another one I like going to, I like the BBC…I feel it's another opinion outside of the United States and gives us a European kind of look at things."

Kelly and Christy indicated personal connections to resources presenting information relevant to where they had grown up. Kelly showed an increase in climate change when she read about drought impacts to her childhood home in Arizona. Christy found a connection to fracking resources as she was curious on any ramifications her childhood hometown might face from this practice. Alice and Christy also selected climate change resources relating to their current home town of Savannah.

Alice also stated, "I like to look at recognizable companies…or things that I recognize" and she skipped Investopedia as a resource option because she did not "recognize this website." Addy also mentioned for "science stuff, I always go to National Geographic…I feel that's the most trusted site from my experience, because it's a lifelong experience I've had with National Geographic, from the magazines and having access to those in my household growing up and continuing to get those."

Familiarity does not mean the source is always credible. For instance, participants indicated a level of skepticism when viewing a user generated webpage like

Wikipedia.com but used this webpage in their searches because it provided an entry point or inspiration for terms to search during their online searches. This was evidenced by similar statements from Addy when she stated that "I usually stop into Wikipedia real quick. I don't feel it's a reliable source but sometimes it kind of gets me started in a process for searching for information."

Findings Related to Research Question Three: How do participants evaluate credible controversial science-based information found online?

During this study, the assumption was made that once a participant selected a webpage, the participant had evaluated that resource to be credible and have relevance to their information search. Once selected, how did the participant engage with the resource? This research question targeted the participants' evaluative actions as decisions were made on the resource's credibility. Participants seemed to follow general rules on evaluating information credibility when dealing with controversial science-based information. Table 14 lists the themes identified to support this research question and Figure 16 visually displays the research questions, themes, and findings in a concept map. The concept of "understanding" was connected to both hemes one and four.

Table 14. Themes Relevant to Research Question Three.

Theme	Description
Theme 1	Credible controversial science-based information must use appropriate language
Theme 2	Controversial science-based information repeated on different resources is accepted as credible
Theme 3	Credible resources present "both sides" of a science-based controversy
Theme 4	Controversial science-based resources perceived as "useful" are perceived as credible
Theme 5	Credible controversial science-based information connects to other resources

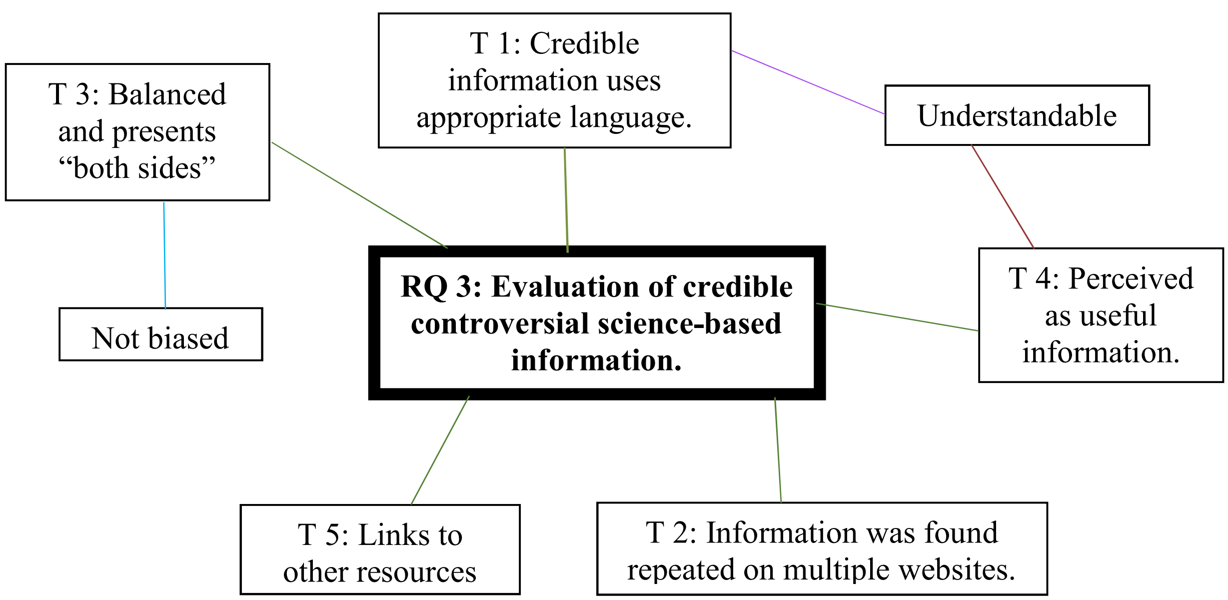

Figure 16. Concept Map of Research Question Three and Themes.

Theme 1: Credible Controversial Science-based Information Must Use Appropriate Language

Participants engage with science-based information on their reading and comprehension level. Science-based resources perceived as too elementary or too advanced, caused participants to become frustrated. Participants such as Leslie mentioned a need of science-based resources to be written in “layman’s terms” while Alice and Nathan desired resources providing holistic background information on the specific science topic. However, resources going “too in depth” were avoided (Nathan). Joan stated “I just kind of read through and find things that sound like something that I can understand, something that will answer the question. You know, just those kinds of basics.” She also went on to say she liked a particular webpage because “it's fairly straightforward. It's fairly simple, and it's very concise. It's something that I can understand, and it's answering my question of, ‘Where are these gases coming from?’ It was very understandable.”

Leslie got very frustrated for not finding a “simple” definition for fracking that was in “simple layman’s terms.” In narrating her search during the stimulated recall interview, she indicated three different attempts to get at a simple definition. When asked what she meant by *simple*, she responded *simple* meant “it’s not a bunch of scientific terms which the average human being has no idea of what they are doing” and specifically, she stated that simple meant “it wasn’t a ton of large words that [she’d] never know in [her] life.” Kelly acknowledged restructuring her search because she did not “want to get a headache from having to think so hard” about terms in a resource. Nathan indicated similar thoughts as he decided to end a search thread on fracking water because the information was “too in depth for right now.” Despite the language being over simplified or over their heads, most participants indicated ending their searches with an understanding of the controversies linked to the science-based information they had researched.

Theme 2: Controversial Science-based Information Repeated on Different Resources is Accepted as Credible

Every participant was familiar with the terms fracking and climate change prior to participating in this research study since interest in these subjects was a criterion for research participation. As each participant began their search, they each tended to establish a definition of the term. In doing so, most participants accepted a general, often authorless definition of the controversial science terms of fracking and climate change. Afterwards, they would spend a portion of their search vetting and verifying this definition against other, often known resources. Participants recorded this definition in whole or part, then compared the initial authorless definition to content from known sources. The definitions were predominantly supported, with minimal modification on the details, such as adding information on fracking water (Nathan) or earth quakes (Christy and Julie). Alice explained her credibility evaluation process in that she wanted “to get a definition then I just type in a general search for it.” She took the first “general” and “unbiased” definition she found online, then checked it against “the definition, against the definition against additional definitions” from additional pages she selected during her search “to make sure it [the original definition] was right.”

Even after an initial definition was determined, participants seemed to constantly compare new information from different websites to other websites in efforts to gauge its credibility. Joan stated, “if I'm going to find the same information repeatedly, then it gives it more credibility.” The idea of repeated science-based information being considered credible science-based information is repeated by Julie as continued searching until she found “more of the same thing. Kind of back checking, kind of. Make sure everything else has the same kind of ideas of what I already wrote down.”

Addy noted that she specifically checked the credibility of a user-generated site like Wikipedia. She “always validate Wikipedia though. I don't think I've ever sat there and told somebody ‘this is it’ because of Wikipedia. I don't think I would ever claim that either if I did. So, I probably went to BBC or National Geo[graphic].” Leslie and Nathan indicated they typically accepted repetitively found information of similar meaning to be credible information.

Theme 3. Credible Resources Present “Both Sides” of a Science-based Controversy

Participants repeatedly noted they were looking for credible information which lacked bias. Their perceived credibility of science-based resources was impacted by the presence or absence of arguments for these controversial topics of fracking and climate change. In talking about a resource Joan considered credible, she stated

> So, these myths that were cited, and some of them were positive, and some of them were negative. [The webpage] debunked one way or the other on some of these things, so I thought that was probably good, because they were giving two sides of the story, and it wasn’t simply one way of reading it.

Addy, Christy, Nathan, Julie, and Leslie indicated that the resources they accessed were deemed credible if both sides of the controversial arguments were presented. In resources presenting multiple arguments, four participants (Alice, Christy, Julie, and Leslie) noted they were able to trust that the information to be from a reputable source.

One of those participants, Christy, did indicate a bias by identifying a funding agency visible on one of the resources she had accessed.

Alice read a resource pertaining to fracking and stated that "I read it and realized that, OK, that's general enough and doesn't look too biased." Later in her fracking search, she identified a time when she noticed bias and stated that "I realize that this [resource] is extremely biased because of words such as 'safely' and 'gradually' and there's a bunch of words in there that make it 'oh, it's such a natural happy process' and I can tell that based on the language. So, it doesn't take me too long." She explained the biased language indicated an "agenda" so Alice then navigated away from this biased source.

Leslie identified "both sides" of issue be representing the "pros" and "cons" of a topic. She seemed almost relieved to discover one resource, a presentation, as she stated

> I'd finally found the answer in pros versus cons after searching…. this was a really good webpage as it would say the issue first, then the questions and then pros versus cons. Pro, this is what's good about the subject. Con, this is what's not good about the subject. So, it really weighed both factors.

Similar to Leslie, Julie commented on the pros and cons as she stated, "this website looks like it does a good job of explaining both sides." She went on to acknowledge an appreciation for this resource as she stated,

> So, that's good in this controversy that a site acknowledges both sides because it if doesn't then it's really one sided and it's hard to tell if it's actually telling the truth of if it's just like so one sided that it's fabricating it.

Lastly, two participants made references to controversial science topics having a partisan or political component. Addy selected a BBC fracking resource which provided a non-US perspective as she thought "[The US] might have monetary reasons to have something and [BBC] might not, or vice-versa. There's politics, of course. Since we're a democratic country." Addy preferred to have "both sides" of an issue and Wikipedia provided a multi-dimensional resource as "it gets my brain going in the right direction, or an alternative direction if necessary, making sure I have both sides of it. Christy mentioned her preference for resources that "seemed to be examining statements from both opponents and proponents for fracking, and [the webpage] covered quotes from politicians as well as from, like, protestors, and folks who generally seemed to have like a stake in [fracking]."

Theme 4: Controversial Science-based Resources Perceived as "Useful" are Perceived as Credible

Science-based resources deemed to be "user-friendly" or "engaging" were evaluated as being more credible. Addy described credible information as information presented in an engaging manner. Other participants identified additional user friendly or engaging characteristics which signified credible information; for instance, Julie noted credible information was presented concisely in lists and Addy and Leslie indicated credible information was presented as bulleted key points. Concise and truncated resources made information easier for participants to locate was also deemed credible. Simple messages increased perception of credibility and increased the participants' engagement with the credible resources as captured through data from Joan, Kelly, and Leslie.

Participants self-identified preferences for text based, or graphics-based resources. Text-based participant, Christy, indicated the importance of avoiding "loaded language" and graphics-based participants, Nathan, Leslie, and Kelly, actively sought images and graphs during their information searches. Leslie valued diagrams as “it was cool actually putting the words into a process of what exactly is fracking.” Addy identified her “preferred [resource] is videos” as she “typically would’ve probably hit the different videos, versus reading articles.”

When engaged with a resource they had identified as credible, Addy, Christy, Joan, and Nathan noted during their stimulated recall interview a *reading* behavior as opposed to a *skimming* behavior. Skimming was a behavior associated with resources not identified as pertinent to the search or not perceived as credible. The notion of *reading for engagement* came to light by these participants but was best captured by Addy who preferred to visit resources known to be visually stimulating like National Geographic as it “has a lot of visual interests and engages” her. Addy mentioned “skimming” resources to save time as opposed to “reading” resources. She also noted a different approach to items valued as credible. For instance, she “didn’t skim and scan” every resource, but she “actually went through and read” those that interested her. Another participant, Christy, noted she skimmed over the resources not consider as relevant to her information search. For instance, she skimmed over resources in the search result list and she skimmed through accessed resources because they were from a differing geographic location.

Theme 5: Credible Controversial Science-based Information Connects to Other Resources

Participants commented on the importance of credible science-based resources being perceived as being fact-based. Two criteria identifying characteristics of fact-based controversial science information was the presence of in situ hyperlinks to external resources and the presence of a reference list noted at the end of a resource. Julie, Christy, Nathan indicated these resources were perceived as credible when facts were referenced, and these sources were cited.

Resources providing hyperlinks, embedded links to external or supplemental documentation, were also considered credible by Leslie, Julie, and Nathan. One example provided by Julie, was when she stated a credible webpage had "a lot of stuff where you click on it and you can go somewhere else." She thought this was an effective way for resources to show they had cited their sources as it "makes it feel better-more trustworthy." Providing these additional resources assisted participants in checking credibility of information against other sites, thus impacting credibility perceptions.

Additional Findings

The last section in this chapter presents findings identified in addition to the participants' approach and the three research questions. These additional findings include those relevant to emotions of online searching, the concept of time being a constant consideration when learning online, the suggestion of a drive to find the "correct" answer when conducting an information search, and the idea of learners shifting from learner to learning facilitator.

Searching for Online Science Information Can Bring Out One's Emotions

Several participants referenced an emotion they felt during their search. Addy was "happy" when she landed on the National Oceanic and Atmospheric Administration (NOAA) webpage because it was a familiar source and a trusted source of information. Julie indicated she became "frustrated" when the research laptop was not linked to a university library she had grown used to accessing on her personal laptop. By not accessing this library, Julie's frustration grew since she could not read through scientific journals which were resources she had deemed as credible information. Lastly, Leslie indicated two emotions in her stimulated recall interview, disappointment and frustration. Leslie had conducted her search using GoogleScholar.com, yet it appeared she did not intend to use this search engine and was unfamiliar with this search engine. She indicated she was "disappointed" in not finding definitions for the terms and then being "frustrated" as she continued to look for a definition she knew existed on the Internet, but never surfaced during her search. Emotions impacted the participants' searches in some capacity. Addy seemed to stay longer and engage with more subpages on this known resource. Julie and Leslie began to sporadically click on resources from the search result list when they became frustrated.

Time was a Constant Consideration

Time seemed to be on each participants' mind throughout their searches in some capacity; for example, time spent on defining the topic, time spent scrolling through the search result list, time spent engaged with a resource, time spent responding to a computer prompt. The concept of time consideration manifested through several comments from participants regarding the time spent on resources, the notion they were wasting time during their search, and the time spent determining a "correct answer" to the computer questions. Addy noted she went through some resources "real quick."

Another participant referencing time was Alice. Her reference pertained to time investment in locating resources on a webpage. When discussing her search during the stimulated recall interview, a webpage with a slideshow of photos and captions was accessed. She navigated away from this page as she explained, "I have to click for each one, I clicked right out. I don't want to have to scroll for each one and I'm like, this is going to take too much time." Christy also eluded to time impacting resource selection as she did not select a resource because "I don't really know that I have time to look up what [DUP] is right now." She also considered time during an informational search as she mentioned that resources needed to be concise, especially "when you're researching something, and you don't have four years to do it."

Despite being told to "take your time," Julie stated she "didn't want to take too long" when conducting her information search but said she felt comfortable with the amount of information she encountered to formulate her response to each question. Nathan had a definite strategy in which he sought to efficiently use search time. Nathan opened resources from the search result list as new tabs to "save a little bit of time." His rationale was that he could open a new resource in a new tab, and while it loaded, he could continue scrolling through the search result list and selecting additional resources for new tabs until he had opened a sufficient number of resources to review. At this time, he could toggle between the various tabs of resources. No other participant exhibited this search behavior, and the other participants seemed to prefer selecting a resource, allowing the resource to load, accessing the resource, then navigating to another resource once finished. Nathan seemed to think about time, but then continue with resources of interest as his search was the longest search time of 41 minutes.

The Personal Drive for a "Correct" Answer

Participants had a personal drive to provide a "correct" answer to the computer search question despite the initial caveat stating there was no "right" or "wrong" answer to either of the computer search questions. Joan, Kelly, and Julie indicated they sought to find a "correct" answer for the search questions. Julie went on to relay the computer search portion felt like a test and she wanted to perform well on the test by providing a correct answer.

Learners Must Now be Facilitators of Learning

Eight participants were exposed to over 800 online resources and selected a fraction of these resources, 142 to be exact, for use in crafting their responses to the two computer questions. Several participants indicated some level of a learning conflict encountered during the study's computer search portion. In Nathan's climate change search, he narrated contents of a resource containing information on ice cores and their role in noting Earth's temperature history. During the stimulated recall interview, he reflects on this resource and states "I'm going through my mind like, wow, this doesn't make any sense to me…the whole temperature in the middle of the ice." But when asked to clarify what part did not make sense, he stated "I feel comfortable with ice cores now, so I think…I have a moment where I'm trying to figure out what else about climate change I want to look into."

Joan also indicated a point where she shifted from learner to facilitator. During the climate change portion of her stimulated recall interview, she said "[I] got pretty much what I wanted to understand." Joan had defined when she had met her learning objectives. Another participant, Addy, indicated she was "looking for bullets [of information] …the bullets were things that I can relate to or have some prior background knowledge in. I can go get further knowledge and feel comfortable." Like Joan, Addy was facilitating her learning as she indicated when learning had occurred and the means in which learning occurred. Both participants seemed to know the format of resources preferred and the level of knowledge they sought to obtain. The next chapter discusses these findings that have been presented in this chapter along with the conclusions drawn from the findings.

CHAPTER FIVE

SUMMMARY, CONCLUSIONS, AND RECOMMENDATIONS

The following chapter is divided into five sections including the 1) summary and integration of the findings, 2) major conclusions drawn from the study, 3) implications for practice, 4) recommendations for further research, and 5) concluding comments. The first section presents a process model to provide a visual summary and integration of the three-part findings (Participant Approach, Research Question, and Additional Findings) presented in the previous chapter. The second section presents and discusses the two major conclusions garnered from the findings. The third section presents implications for practice based on the study. The fourth section offers recommendations for further research. Concluding comments end the chapter and provide reflection on the study.

Summary and Integration of Findings

The purpose of this study was to examine the ways in which adults, specifically non-science experts, identified credible online science-based information during real-time Internet searches. The study was guided by the Hilligoss and Rieh's (2008) Unifying Framework of Credibility Assessment model (see Figure 1). This model was selected as it best captured the personal nature of how learners make evaluations pertaining to information credibility and the impact the learning context on these evaluation decisions. Hilligoss and Rieh's (2008) model pertained to a wide group of learners, a general scope of subject matter, and a diverse type of media, books, peers, and Internet to name a few. The current study, based on layers of the Hilligoss and Rieh (2008) model, narrowed credibility evaluations to one context, a bounded adult audience, and a specific subject matter. The current study's process model presented in Figure 17 integrates the themes and findings of the current study into the *Construct, Heuristic*, and *Interaction* layers presented by Hilligoss and Rieh (2008) providing a visual roadmap for this chapter. The process model includes a unique layer due to the specificity of the study's subject matter.

A Process Model of the Findings

As seen in Figure 17, the current study's process model is comprised of five boxes. Each box represents a set of findings from this study. The topmost box, *Participants' Approach*, includes findings related to the participants' interaction with the computer and Internet. These are contextual findings provided to orient the ways in which participants interacted with the Internet and computer during the computer-based information search. These findings include the participants' software selection, search term selection, and computer-based considerations while engaged with information searches on the Internet.

The next three arrow and box sets incorporated into the dashed outlined area of the model identify the three research questions and salient themes. The three arrows contain the research questions used to guide the study. The three boxes list the salient themes underneath the relevant research question arrow. These themes were derived from the study's findings and presented in Chapter Four.

Hilligoss and Rieh's (2008) model was oriented in a top-down manner to best illustrate the influences of the topmost layers on the underlying layers. The present study's process model assumed the same orientation as the topmost arrow and box set, the *Participant's Approach*, influenced the next box set (RQ1), and so on. The top-down approach illustrates that, while the topmost and bottommost box are not directly linked, the topmost element is influential on the outcomes of the bottommost element.

For the current study, the box, labeled as *Construct,* represents the participants' definition of *credible science information* and was identified through research question one (RQ #1: How do non-science experts define credible science information?). As with Hilligoss and Rieh's (2008) model, participants' constructs used in defining credible science information were unique and served as lenses through which participants perceived the credibility of online science-based resources. This construct lens is unique and impacts the general rules and cues participants used to select credible science-based information.

Continuing down the model, the next box contains the second research question. Research question two (RQ #2: What general rules and cues do participants use to select credible science-based information during online searches?) is denoted in the *Heuristics and Interaction* box. While *Heuristics* and *Interaction* were separate layers in the Hilligoss and Rieh (2008) model, these layers were merged into a single layer in the present study's process model given the speed and reiterative nature at which decisions are made on general rules and cues of resources when learning online.

The *Study Specific Interaction* box set represents a new layer not in the Hilligoss and Rieh (2008) model. This layer represents the third research question which focused on the specificity of the current study's subject matter, the controversial science-based topics of fracking and climate change (RQ #3: How do participants evaluate credible controversial science-based resources found online?). This layer is influenced by the

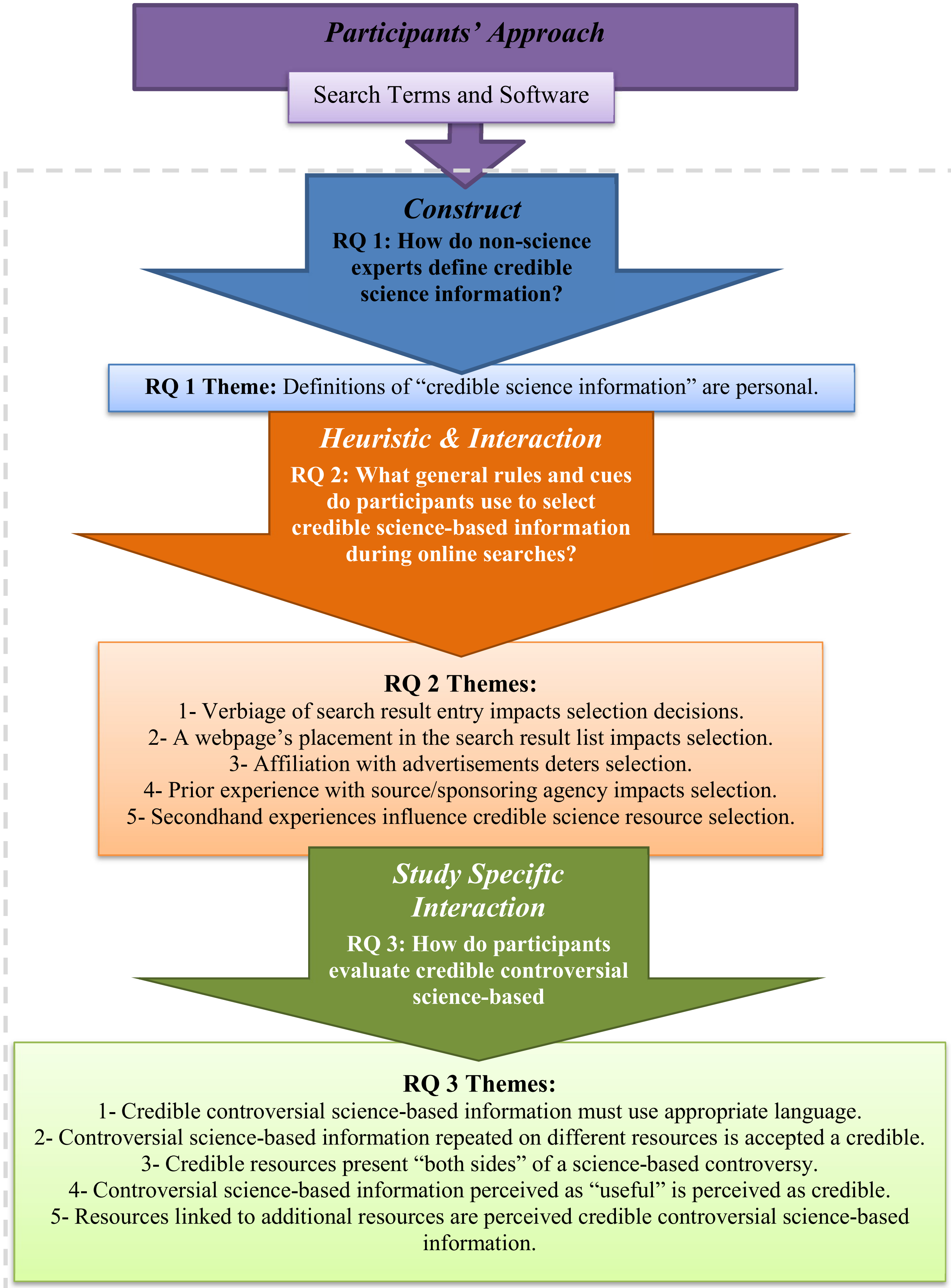

Figure 17. Adapted Hilligoss and Rieh (2008) Model.

upper layers and pertains to the specificity of the content area of controversial science-based resources and resource attributes impacting selection.

There were additional findings, representing findings and themes in addition to those pertaining to the *Participants' Approach* and the *Research Questions*. These additional findings contributed to the major conclusions identified in the following section and these findings identified implications for further research. Additional findings from the current study pertain to notions of emotions in online learning experiences, time considerations when learning online, and findings to support current literature on adult learners shifting to adults becoming facilitators of their learning. From the study, two major conclusions were drawn. The following section discusses both major conclusions, the themes on which they were based, and pertinent literature.

Major Conclusions

The real-time data generated in this study by the small and homogeneous non-science expert participant pool brought two major conclusions to light regarding their evaluation and judgement of online credible science-based resources. The current study sought to evaluate how non-science experts went about identifying online resources as credible in a topic area out of their realm of expertise. Findings and themes from the current study yielded two major conclusions further discussed in the following sections of this chapter.

The two major conclusions and supporting summative statements gleaned from the study's themes are presented in Figure 18. The first conclusion supports the way in which participants evaluate resources. The notion of prior knowledge served as the driving mechanism behind the participants' decision-making rationale in evaluating and selecting credible resources encountered online. Their prior knowledge and collection of experiences influenced the manner in which they assigned credibility to the resources they encountered. The commonalities in the ways in which participants assigned credibility to the online science-based resources serve as the foundation for the study's first major conclusion.

Major Conclusion 1:

Prior knowledge impacted credibility assessments of online science-based information.

- Participants prefered familiar search software due to prior experiences.
- Prior experiences of each participant impacted credibility assessment.
- Experiences and opinions of others impacted credibilty decisions throughout the online learning process.

Major Conclusion 2:

Participants, although non-science experts, possessed various literacy skills necesssary to critically evaluate controversial science-based information encountered online.

- Participants sought multiple sources when differentiating credible science information.
- Participants showed digital literacy skills in locating multiple science-based resources on the Internet.
- Participants showed science literacy skills by providing accurate definitions and understanding of the science processes of fracking and climate change.
- Participants showed information literacy skills as they presented valid arguments on why some might consider each scientific process controversial.

Figure 18. Major Conclusions and Summative Statements.

The second major conclusion is founded on the tenets of the tripartite literacies, digital, science, and information. These literacies have been discussed in detail in Chapter Two as they have been identified as essential in today's adult learning environment, yet literature on the presence of these literacy skills in the adult populace is lacking. These three literacies are an integral component for adults continuing their self-directed educative pursuits in today's learning climate driven by unprecedented advances in the fields of science and technology.

The current study's research sessions were implicitly designed to investigate the non-science experts' skills in science literacy, digital literacy, and information literacy as they were asked to formulate thoughtful responses in a new and controversial content area. I wanted to evaluate how adults researched a new and controversial science-based topic to extend beyond a definition and to identify arguments on the controversy behind the science. In identifying the arguments, participants made judgements on the resources they had selected for incorporating into their research as they formulated a response regarding ways in which fracking and climate change caused concern for others.

The computer prompts asked the participants to go beyond rote search and find strategies of identifying possible controversies posed by the new scientific process. Through this approach, the current study captured real-time data pertaining to levels of digital literacy skills in locating information, science literacy skills in understanding the overall scientific process, and information literacy skills in critically reflecting on the credibility of the conflicting information they encountered on the Internet regarding these controversial scientific processes. The following sections further discuss the conclusions.

Major Conclusion One

The first major conclusion gleaned from the present study pertains to the role that prior knowledge plays in determining resource credibility and the ways in which prior knowledge impacts the selection decisions during online science-based learning. Figure

19 visually depicts the first major conclusion identifying three summative statements and the themes from which these summative statements were drawn. Themes supporting the summative statements are included in an abbreviated form on the right most side of the figure. Given the abbreviated nature of the themes noted in the figure, reference codes are provided as a reference to connect the condensed themes back to full verbiage presented in the process model (Figure 17) provided earlier in this chapter.

Prior knowledge from past experiences. Experiences impact learning, yet these experiences extend beyond one's individual experiences and include the experiences of others, also known as secondhand experiences (Wilson, 1983). As discussed in Chapter Two, cognitive authority represents firsthand and secondhand experiences (Rieh, 2002). Cognitive authority is considered as a relational authority since it is derived by constantly sorting and comparing new information to existing (Wilson, 1983).

As Wilson stated, cognitive authority is created in one's perspective and exists in a perpetual state of motion, constantly evolving as new experiences and information is processed (1983). Cognitive authority manifests from the collection and interactions of our prior knowledge and experiences. When adults learn online, decisions on information credibility happen rapidly and, as the findings indicated, the collection of prior knowledge and experiences drove the decision-making process. The following paragraphs discuss the first major conclusion of the present study and the role of prior knowledge in credibility assessments.

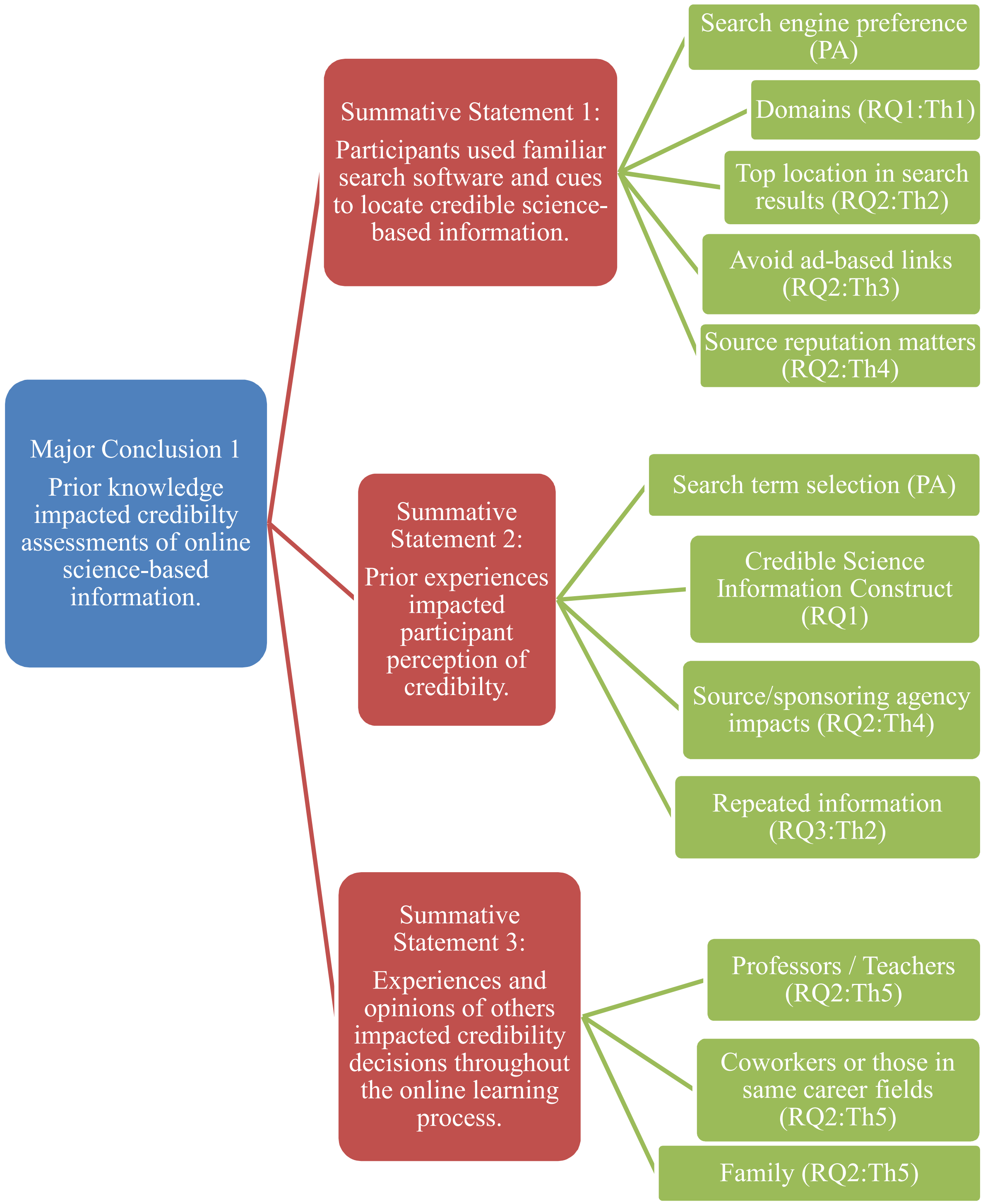

Figure 19. Major Conclusion One, Summative Statements, and Supporting Themes.
(PA- Participants Approach, RQ- Research Question, Th-Theme)

Summative Statement 1: Participants used familiar search software and cues to locate credible science-based information. Most participants noted using familiar strategies in their search strategies. Some preferred certain search software, some preferred certain webpages, some preferred certain sponsoring agencies. While some participants could identify rationales behind these strategies relating back to specific prior experiences, some participants had no definitive reason except for familiarity. Familiarity based on positive experiences caused repeated use of search behaviors and resources while familiarity based on negative experiences caused avoidance of software or resources. Negative experiences caused the participant to actively avoid, without consideration.

Familiarity in the participants' approach was identified by several participants, Nathan and Julie and Alice. Each made a reference to their use of search software being based on familiarity with particular software or the quality of the resources it yielded in a search. Even though familiar software was noted, Julie and Alice, unknowingly and successfully searched for information on different software only noticing this use during the stimulate-recall interview. While several participants indicated a preference in software selection, only two participants, Alice and Nathan, acknowledged search engine limitations and algorithms used in formulating search results lists. Several participants indicated a preferred search engine yet did not actually use that software. While participants spent similar amounts of time searching for credible science information on fracking and climate change, participants varied in their search strategies. Most participants voiced a preference for Google as a web browsing software which was supported in the data for both fracking and climate change information searches.

Software options were finite, but the search terms used to locate resources were infinite, yet the maximum number of search terms entered was eight.

If a web address or domain was presented in the search result list, it was often factored into the selection process. If a web address or domain was not presented, then it typically was not an issue in selecting or avoiding the resource. Most participants indicated being leery of .com domains given the controversial nature of the topics. Despite these espoused feelings towards the domains, .com resources comprised a majority of fracking resources (51%) and almost half of climate change resources (43%) that the participants utilized in their credible information search. This discrepancy in espoused behavior and actual behavior might be due to participants not being aware of resources labeled as .com resources. For instance, the British Broadcasting Channel (BBC) has a .com domain and was one of the most popular resources for participants in this study.

Participants also showed tendencies for using familiar habits when evaluating and selecting resources listed in the search result lists. Participants tended to select or ignore resources simply based on familiarity with the domain. As discussed in Chapter Four, participants indicating domain preferences sought .gov, .edu, and .org resources due to familiarity with the domain and prior experience with the sponsoring agency. However, .com resources were avoided unless the participant was familiar with the particular .com resource. Participants tended to select the first few entries, avoid ad-based links, and weight reputation of source as a factor in credibility decisions.

Participants seemed to skim the text of search result entries, selecting the top few search results, the initial text box indicating a definition, or searching for text that "caught their attention." These behaviors can be interpreted to be participants trying to find the best resource in the shortest amount of time. Research reported a tendency of adults t0 demonstrate a "snatch and grab philosophy" when they became frustrated with slow search results or search roadblocks (Halverson et al., 2010).

Advertisements seemed to deter participants from a resource; in fact, endorsements for websites seemed to diminish the credibility status of websites. Past research indicated a relationship between source-ad pairing and perceived web credibility (Greer, 2009). However, in this present study, participants seemed to avoid selecting any resources located near a green advertisement logo box. Greer (2009) suggested trusted resources might still be selected despite an ad link; however, in this present study, the green advertisement logo box seemed to deter all participants from selecting such resources. I would add that the participants from the current study did not heed the resource for any length of time to make a judgment on the reputation of the resource. Participants completely ignored ad-linked resources. The last supporting theme pertains to reputation of the source agency as the present study's participants tended to select resources published by agencies familiar to them.

Summative Statement 2: Prior experiences impacted participant perception of credibility. When probed, most participants eluded to prior individual experiences that were drawn from when selecting or avoiding certain online resources. While similar to Summative Statement One regarding familiar software and cues, Summative Statement Two focuses on firsthand experiences drawn from the actual resource, not from the process. These firsthand experiences with the sponsoring agency or organization seems to stem from interactions with the agencies from years earlier and many of these experiences have not been on the Internet and have not involved controversial subject matter.

Online learning seems to build on individual experiences learners have established with those that publish information. Addy loved National Geographic as a child; therefore, Addy continues to love National Geographic. Joan trusted National Aeronautics and Space Administration (NASA) for weather information; therefore, Joan trusts that NASA is a credible climate change resource. Nathan uses information from Wikipedia as inspiration for information searches with an understanding to be leery of non-peer reviewed, user-generated content. These firsthand experiences seemed to influence credibility perceptions and the ways in which participants engaged with the resources.

Earlier discussion in Chapter Four identified the ways in which the eight participants defined credible science information (Research Question ONE). Each participant defined the construct differently. Some valued usefulness of information. Others valued facts and unbiased presentation of information. Establishing an operationalized definition of credible science information with each participant showed their individualistic approach to learning about controversial science-based processes online. Participants entered in to this online learning endeavor with prior experiences that molded their current science epistemologies and assisted them in assigning credibility to resources.

Britt et al. (2014) indicated that adult learners face enormous hurdles when tasked with determining credibility of science-based information online. From this present study, two ways in which adults have responded to the challenge of learning science online is to seek resources published by familiar sources and compare newly discovered science-based information across multiple sites, including familiar and new sites. This unanimous approach by the participants to utilize multiple resources significantly implies that participants are actively cross-checking facts. This behavior is significant as it suggests the likelihood that participants have general science-based truths, or scientific epistemologies, already in place. These epistemologies, while not rooted in the new subject matter, are based on prior experiences and are being used as an evaluative lens to assess the new and controversial information.

Experience with science-based resources, current and past, seemed to be significant in considering science-based resources online during a new subject matter learning transaction. Based on the current study, these prior science-based experiences had a direct impact on the perception of science-based resources on the Internet and, ultimately, selection of science-based resources. Christy identified and selected *Popular Mechanics* as a credible resource for her to learn more on these controversial science topics due to name recognition from childhood. Christy remembered reading through this magazine when she had visited daughter's office as a child and she has since thought of this magazine title to be a "reputable source." Another participant, Addy, had similar experiences with another magazine, *National Geographic.* She selected this resource as credible in a fracking and climate change search.

Assigning credibility to new and complex science-based information is a multi-faceted task as it requires many aspects to be weighed by the learner during the decision process. Participant's experiences (firsthand or secondhand) greatly impacted their credibility criteria and their resource selection. The last section regarding Major

Conclusion One, pertains to the social side of cognitive authority and the implications of the collection of prior knowledge and experiences on assigning credibility to science-based information. The concept of cognitive authority and this relationship between people and experience begins to touch on the social nature of online learning and how learners assess information as credible (Tseng & Fogg, 1999).

Summative Statement 3: Experiences and opinions of others impacted credibility decisions throughout the online learning process. Credibility of resources encountered online during the controversial science-based information searches was influenced by the opinions of others. For instance, Julie spoke of an academic experience where a collegiate professor shaped her search strategies to avoid user-generated science content, such as Wikipedia, and search out vetted peer-reviewed resources on GoogleScholar.com. The professor indicated that user-generated online media was not trustworthy since it was not the original source of information and he urged his students to find the original source of information. Nathan, on the other hand, was influenced by others in his field as he was a teacher and sought teacher generated resources as he assumed they used an acceptable level of professionalism in fact checking lesson plan resources.

Earlier research by Rieh (2002) suggested participants in her study seemed to trust like-minded sources or “scholarly” looking sources as they were scholars (p. 156). Participants of this study also indicated a search strategy of visiting “like-minded” sources. Participants admitted to having their “go to” sources. These sources were used for general Internet-based information searches, not just for specific science-based searches.

Further experiences, such as geographic connections to cities and locations where the participant or their families had lived or were currently living, proved pivotal in engaging participants in certain online science-based resources. Participants seemed to tap into an empathetic layer on the impacts of fracking and climate change based on their individual experiences with these geographical locales under pressures from fracking activity or changing climate. Noticing a familiar location in these resources seemed to give the resource credibility and pique the interest of the participants. Again, these experiences are variables in online learning transactions as they impact perception of credibility and conversely impact the learning outcome. Also, this connection between participants and geographic place seemed to increase engagement and recollection of the information gleaned from the resource. Based on participant data from this present study, I would argue these experiences are a part of what Metzger et al. (2010) discussed as shortcuts that have been created by users to reduce time invested and cognitive load when tasked with making decisions.

Major Conclusion Two

The second major conclusion drawn from the current study pertains to the ways in which participants responded to the computer prompts. In responding to the two computer-based prompts, participants were implicitly tasked in using their digital literacy, science literacy, and information literacy skillsets. Each of these skills was explored as participants searched for information to craft science definitions and come to an understanding of why others might have concerns regarding the two controversial science-based topics, fracking and climate change.

Figure 20 depicts Major Conclusion Two and the four summative statements based on the themes and findings from the current research. Themes supporting the summative statements are included on the right side of the figure. Given the abbreviated

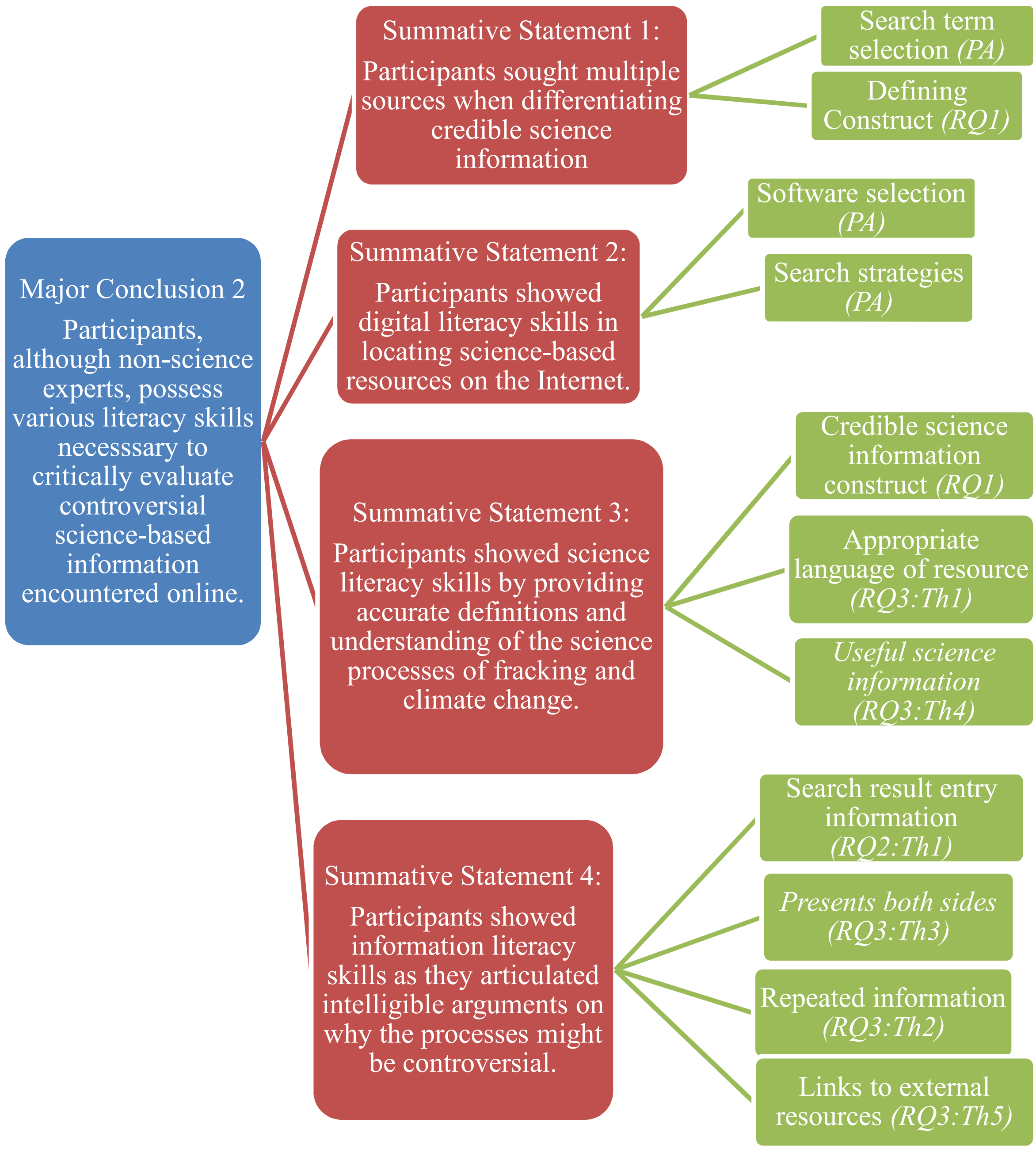

Figure 20. Major Conclusion Two, Summative Statements, and Supporting Themes.
(PA-Participant Approach, RQ-Research Question, Th-Theme)

nature of the themes noted in Figure 20, reference codes are provided to connect the themes back to the study's process model presented earlier in this chapter.

Literacy skills: Digital literacy, science literacy, and information literacy. An earlier study by Wiley et al. (2009) discussed the tasks of online learning with a focus on users' processing and comprehension capabilities. Understanding the relationship between an adult learner and the digital learning platform is proving important in the adult education field. Takahashi and Tandoc (2015) suggested the Internet is replacing traditional sources of information. The authors theorize brick and mortar library buildings is being replaced by touchscreens and hyperlinked documents (Takahashi & Tandoc, 2015). Adults are going online to learn as The Pew Research Center (Horrigan, 2016), a non-partisan nonprofit research group, stated that three fourths of adults learn online.

To learn science-based content online, I argue on the shoulders of the research presented in this current study and the body of research that this study has been built upon, that adults should be equipped with a tripartite literacy skillset of digital literacy skills, science literacy skills, and information literacy skills. I find relief that participants of the current study exhibited competencies in the tripartite literacy skills and encourage continued efforts given the technological advances in the areas of science and technology. The following paragraphs discuss the basis for the four summative statements on which Major Conclusion Two was drawn.

Summative Statement 1: Participants sought multiple sources when differentiating credible science information. The computer search prompts were crafted carefully with the intent of having participants formulate a definition of a controversial science-based topic and then identify concerns society has associated with these topics.

The prompts had no correct answer and allowed participants to delve into varying levels of details during their information search. Participants were also responsible for ending their information search meaning they were responsible in determining when their learning had been fulfilled.

Participants used multiple search term strategies and multiple information sources during their search to identify credible science-based information and come to define the construct. Some participants preferred to search through few resources and linger longer while others sought a wider resource pool. For instance, Kelly completed her search using few resources (two of the seven) from that search result and Alice went deeper and used seven of the 83 fracking resources she had encountered on that one search term. For their climate change searches, these participants had similar approaches with both using two search terms and accessing approximately the same percentage of resources, Kelly accessed three (16.7%) and Alice accessed nine (11.1%).

Overall, Kelly selected few resources and spent her entire search reading through these sources. Liz and Nathan selected a substantial number of resources but engaged with a small fraction of these resources for a small amount of time. Participants seemed consistent on their search strategies when comparing their approach and search behavior between the fracking and climate change searches. Irrelevant of their approach, software, or strategies, the participants noted scientifically accurate definitions and concerns for both fracking and climate change.

Summative Statement 2: Participants showed digital literacy skills in location science-based resources on the internet. Hargittai & Shafer (2006) noted adults with digital literacy skills navigated and learned through the online environment effectively and efficiently. Participants from the current studied showed a level of digital literacy as they located information efficiently and effectively during each the research sessions. This study's participant spent time with the resources they deemed credible and accessed while conducting their information searches. Data suggested the eight participants spent over half (58.9%) of their search times engaged with opened resources. Of the sixteen searches (eight fracking searches and eight climate change searches), nine searches indicated the participants were engaged with resources over 80% of their search time. These metrics indicated that participants were locating information and engaging with the resources for significant portions of their searches. From this behavior, I suggest that these participants displayed functioning levels of digital literacies since they were able to define new science-based terms and locate multiple resources pertaining to those terms.

Summative Statement 3: Participants showed science literacy skills by providing accurate definitions and understanding of the science processes of fracking and climate change. Research indicates online science-based information should be written to reach a wide range of reading skills and learning styles (Britt et al., 2014) as learning becomes problematic when learners do not understand the science content. Halverson et al. (2010) stated the lack of understanding of science content impacts how learners judge resources and how the learner incorporates the information into their learning. This is evidenced by the present study. Participants sought science content they could understand so the content could be incorporated into their information search. When participants encountered conflicting information, they sought additional resources to help make meaning and resolve the conflict.

In making meaning of these topics and evaluating resources during the search process, participants noted that credible science information deemed as “useful” was also deemed as “credible.” Most participants indicated credible resources contained understandable language especially when presenting controversial or argumentative science-based information. Participants tended to navigate away from resources that seemed heavy in science jargon and too elementary in language. Participants wanted to be informed with age-appropriate facts of the controversy and be allowed to formulate their own interpretations. Participants did not want to be influenced by mere opinion or a one-sided presentation of information. Science resources must be short enough to contain accurate information, yet not so long that learners quit reading (Fowler, 2001). Triese et al. (2002) stated that future research on “usefulness” of a science-based website would possibly prove more salient than “credibility” or “accuracy” (p. 330).

In this current study on controversial science-based information, participants showed commonality in tentatively accepting information they had found online as credible until they found the same information repeated on one or multiple subsequent pages. In searching through the resources, participants wanted information they could locate easily on a webpage and they sought resources that engaged them. Participants navigated off the resources they felt to have a confusing layout or displaying other elements not considered “user friendly.”

In comparing the concerns identified for fracking and climate change, participants had located similar concerns for both controversial topics. Fracking concerns pertained to safety of the fluid insertion process, earthquakes that might result from fracking activity, water contamination underground and above ground, increased water consumption, and the ease in resource extraction through fracking negatively impacts dollars potentially used for exploration of more sustainable energy practices. Climate change concerns included the argument on whether it is a human induced or natural induced phenomenon, ocean temperature increases and is melting ice caps causing sea level rise, causing more severe weather, and causing potential animal extinctions. Concerns identified by all participants for both topics were all scientifically accurate concerns.

Research suggests that science literacy skills are instilled during formal school years (DeBoer, 2000). I would also suggest that most participants had increased science literacy skills due to their enrollment in a collegiate science-based course as suggested by Miller (2012) and or a professional science-based training course as suggested by Dimock et al. (2013). Participants in the current study had graduated from high school and all participants had completed some level of post-secondary degree requiring at least one science-based course or training. All participants arrived at a scientifically accurate definition of both controversial science-based terms and provided accurate concerns on the controversial processes.

Summative Statement 4: Participants showed information literacy skills as they articulated intelligible responses on why the processes might be controversial. Both science-based topics were outside of the participants' area of expertise. Participants began their search with establishing a definition of each term which aligned to those definitions noted in *Merriam-Webster Dictionary*. The dictionary noted *fracking,* also correctly identified by the participants as *hydraulic fracturing,* as "the injection of fluid into shale beds at high pressure in order to free up petroleum resources" and *climate* *change* is defined as “changes in the Earth’s weather patterns” (https://www.merriam-webster.com/dictionary).

Watching the participants’ search session and stimulated recall interview video files and spending time with the interview transcripts, it became evident that participants unanimously acknowledged, verbally or through actions, a need to have a greater understanding of the topic. This is apparent as each participant sought to establish an initial definition before delving into why each topic might be considered controversial. With all participants seeking an initial definition, I interpreted this to mean that each participant was acknowledging a knowledge gap. This behavior supports research identifying direct links between an adult’s information seeking behavior, their scientific knowledge, and their critical approach to evaluating the information (Takahashi & Tandoc, 2015) which are all aspects of information literacy.

Just as participants did not use one source to craft their definition of *credible science-based information*, participants did not rely on one sole source of information to craft their responses to the computer search prompts asking why these concepts might be considered controversial. Rather, each participant used multiple online resources during both information searches. Participants used an average of nine resources when compiling their responses to the fracking computer prompt and eight resources when compiling their response for the climate change computer prompt.

As participants narrated their search, each participant described behavior where they spent time checking multiple sources to establish whether resources they had selected were credible. Prior research on credibility indicated that credibility evaluation is an iterative process (Wathen & Burkell, 2002; Warnick, 2004) and participants displayed such behavior in this current study as their definition and responses continued to build and change form with each synthesized resource.

In addition to identifying accurate definitions and concerns for both topics, participants identified instances when the arguments for concerns were one-sided or biased. In discussing these controversial science-based topics, most participants indicated they wanted as many facts as possible to ensure that "both sides" or all sides of the controversy were presented to them. If both sides were not presented, participants indicated they did not find these resources credible due to an obvious bias. Behavior varied in how they responded to biased resources. For instance, some participants, Christy and Nathan, continued reading that resource acknowledging they were interested in what "the industry" had to say about fracking. While others, like Alice, navigated away from the biased resource once she realized the content did not align with her currently held views on the topic. Irrelevant of staying on the resource or navigating off the resource, participants identified a bias and took that into consideration during their learning endeavor. Participants also identified resources as credible when they linked to other resources. Based on comments by Nathan, Christy, and Julie, this notion of credibility being referenced seems rooted in the formal schooling training.

In 2003, Garrison stated that adults need to possess skills that allow them to find and access resources, but also skills and knowledge that enable them to critically evaluate information when learning online. In the same year, Metzger et al. (2003) published research indicating learners used minimal verification to check online resource credibility. Participants from the current study proved themselves competent in both locating credible science-based resources and critically evaluating online resources against their level of understanding. Researchers identified these critical evaluation skills as essential for adults searching for credible resources (Wiley et al., 2009) and these characteristics were identified as main tenets of one whom possesses information literacy skills (Association of Colleges and Research Libraries, 2000).

Information literacy is important to adults who access and engage with SDL through online environments, as these adults must learn to make judgments on information quality (Song & Hill, 2007) as well as synthesize content, and decide the direction in which to continue their search (Association of Colleges and Research Libraries, 2000). Participants in this current study displayed information literacy skills which is evidenced through the real-time data collected during their computer information searches. For instance, all participants showed a competency to locate credible information on their comprehension level as evidenced in their responses to the computer prompts. Participants such as Nathan and Julie synthesized information and widened their searches on fracking as they sought a deeper understanding of the controversial process. Christy, Alice, and Kelly critically engaged with information to apply the processes to their personal lives regarding climatic impacts from climate change. These participants sorted information critically, effectively, and efficiently.

Implications for Practice

The findings from this study suggest, while a simple checklist of credibility might not be possible at this time, I put forward that a credibility checklist might not be necessary for those interested in learning about controversial science online. Experiences and lenses to which adults approach learning science online extend beyond calculations. Rather than solely taxing millions of adult learners with another checklist to follow, I think those that disseminate science-based resources online can help ease the burden of credibility in several ways.

Science has become increasingly lucrative, political, and social. Those responsible for disseminating such resources must take these factors into consideration. No longer can facilities or educators continue to upload science-based content and assume adults are locating those resources or assume the adults are perceiving those resources as credible. The learning transaction is growing more complex due to advancements in science-based subject matter, the technological interface, and the varying needs of the adult learner. This transactional interface if digital learning needs to be built on trusted sources, safe interfaces, and interested adults.

The present study implied that adult learners expect science-based resources to be effectively and efficiently presented to them during an online learning episode. Their expectations of online science-based resources are based on their experiences, but how they have come to operationalize their experiences into an information search is done in a consumer driven manner. For instance, adults want professional looking webpages. Adults want to find items quickly. Adults want the facts, all the facts, not just the pleasant ones. Adults have limitations on what they are willing to consider. Adults value reputation. Adults want to be able to relate. Adults value what trusted others have to say. From the above list, it is hard to differentiate if I am referring to adults shopping for a great pair of marathon running shoes or adults interested in learning more on climate change. Adults evolve in their needs, their thinking, and the ways in which they choose to learn. Therefore, I think it is important to stay dynamic in the ways in which science-based resources are presented to this target audience. Online science-based resources must evolve too.

Implications from this study provide three strategies to assist those who disseminate science-based resources assist their adult audience in assigning credibility, especially when focused on controversial science issues such as fracking and climate change. These strategies focus on ways in which science-based resources and webpages can be formatted and presented to most effectively reach the adult learning audience and increase credibility perception. The adult learner is already assuming a burden in learning new science-based content on the Internet. There are ways to assist their online learning endeavors and share the burden of assigning credibility to the online science-based resources.

Internally Evaluate Online Resources

As identified in this study, adults make judgements on credible science-based information and the webpage on which this information is contained; for instance, domain, link to advertisement, appearance, and language. In considering ways in which considerations of information credibility can be diminished, assistance might be provided in webpage design literature. Findings from this study are supported by webpage design literature that indicated four principal areas that users consider when making judgements on a webpage: 1) the ease of navigating through resources, 2) the visual appeal, 3) the function of resources, and 4) the access to the webpage and resources (Schmidt, Liu, & Sridharan, 2009). Following these four areas of webpage design, those that disseminate online science-based resources can perform an internal evaluation or the resources they have published for public viewing. By taking time and accessing web-based resources from the perspective of a new adult user, insight can be gleaned on how long resources take to load, are resources buried deeper than intended, is navigation through resources as intended, are links to external agencies and resources provided, and are these links active or broken. By spending time on the outside looking in, one can identify areas of improvements. Through these internal critical evaluations of the resources made available online, sponsoring agencies might correct issues to impact credibility perceptions of their resources.

Conduct a Usability Study of Online Resources

Participants from this study identified the credible science information was considered useful science information. In making the connection from being "credible" to being "useful," the study implies web-based scientific resources found to be useful to the adult learner might also be considered credible. To have useful information provided to the adult learner, one might choose to identify how their science-based resources are being used by target adult audiences. Oakley and Daudert (2016) claim that a website's usability study is "a cost-effective way to ensure users can fluidly accomplish intended tasks on a site" (p. 263).

In conducting a usability study, an agency has selected participants navigate through a specific set of science-based resources to accomplish a series of tasks. The participants' feedback on the tasks provide insight into the website's usability. Should participants have difficulty accomplishing the tasks, then the resources might not be as useful as the agency assumed. Offering the opportunity for feedback on web-based resources can provide meaningful insight into how the target audiences are using, or not using, the science-based resources provided online in addition to insight into how the credibility of the science-based resources are being perceived.

Stay Dynamic

Credibility perceptions vary greatly from individual to individual as noted in this research and other research identified throughout this document. There are ways in which resources can increase their credibility perception, but no one way will work all the time or with every type of resource. There is no universal credibility identifier. For this reason, credibility continues to be a "slippery slope" as Rieh (2002) indicated in her research. Given the unpredictability of a learner's perception of credible science-based information, bulleted checklist of how to ensure controversial science-based resources are credible might not be possible. In fact, a content specific credibility checklist might not be needed. The real-time data generated and analyzed in this study identified commonalities in how non-science experts identify credible resources and provided an optimistic perspective that non-science-experts possess skills in digital, science, and information literacies.

By maintaining a currency to digital, science, and information literacy skills, adults might continue to successfully navigate through credible science-based information. Bottom line, constructs used to distinguish credible science information are varied and complex. Narrowing down the participant specificities, context of learning and science-based search topic did not yield a "one size fits all" approach to ways in which one can indicate credible science-based information on controversial topics of fracking and climate change. However, this current research study supports the notion that adults, even non-experts in the subject matter, possess digital literacy skills, science literacy skills, and information literacy skills necessary to critically engage with online resources. The proof of tripartite literacy skills enables these non-science expert learners to facilitate online learning, identify credible science-based resources, and synthesize new science-based information as they strive to make meaning of complex science-based topics. The current study indicated that educators, formal and informal, need to stay dynamic and continue fostering adults to develop the tripartite literacy skills until these skills become "habits of the mind" (Meyers, 2010, p. 51).

Recommendations for Further Research

The current study explored ways in which adult defined and selected credible science-based information online. Findings from the current study add to the literature in adult learning, cognitive authority, digital literacy skills, science literacy skills, information literacy skills, and real-time data collection strategies in qualitative research. Despite the current study, there is much research still needed on how adults learn science online. This current study had limitations. Limitations of this study do not discredit the findings for this study but provide a stepping stone to continue the conversations. Discussing the study's limitations with the study's findings provides several recommendations for further research in these areas. The following section identifies study limitations and provides suggestions on further research based on these limitations and observations surfacing through this present study.

The initial limitation of this study was the small number of homogeneous participants. Recruitment was challenging despite the offering of a gift card and offering research sessions any day over the summer. Despite the complications in recruitment, eight participants were selected. With a small homogeneous group, the data was saturated, but is not generalizable to larger populations. Increasing the number of participants in the pool would provide data generalizable to larger populations and ensure a broader diversity in participant demographics.

Other suggestions for further research pertain to the participants' gender and science background. Participants in the present study were predominantly female (seven out of eight) and all participants were non-science experts. Further research on predominantly males in this age range or a study with equal gender representation might prove valuable data on gender related responses to defining credible science-based information or ways in which various genders engage prior knowledge. Participants for this study were also targeted for not possessing an advanced science degree. Repeating the research methodology with a similarly aged group of science experts would provide comparison data, especially for those interested in furthering investigations into science literacy of the expert versus lay person.

Not a criterion for participant selection or a discussion point for this present study, but political ties would be a valuable focus for a future research study pertaining to credible controversial science-based information. This recommendation stems from several participants who noted a personal or perceived political bias in addition to what is currently happening with the dismantling of several environmental laws pertaining to lucrative and controversial science-based subjects such as fracking and climate change. Further research to collect and compare how members of certain political parties view controversial science information might prove beneficial during today's unprecedented time of ecological undermining and Presidential lies of factual science being "fake news." The notion of scientific facts being questionable is a growing concern when adult learners are checking facts to make decisions on basic and civic minded science-based responsibilities (Mo Jang & Kim, 2018).

While I eagerly anticipate the day that science steps out of the contentious political arena, I do not see it making that step in the foreseeable future. With the unprecedented amount of advancements in science and technology, attempts to learn science through technology can be everchanging; thus, incredibly challenging for adult learners. Digital learning devices and social media are being used at historic highs to disseminate information as a recent Pew report indicated 62% of citizens in the United States retrieve their news through social media outlets (Mo Jang & Kim, 2018). I would recommend exploring how a contemporary shift from laptop learning to smartphone learning has impacted an adult’s search strategy for credible science-based information.

Berry (2001) discussed the importance of keeping technology skills up to date as one’s computer skills become obsolete quicker than any other human skill. In today’s society, computer or digital skills are not optional to function as they provide a lifeline to information far beyond the reaches of controversial science. Currently the Organisation for Economic Cooperation and Development (OECD) is conducting the Survey of Adult Skills, called PIAAC (Program for the International Assessment of Adult Competencies). This survey is available online to adults in forty countries and aims to capture adult competencies in digital technologies. This international online survey probes into adults’ overall digital proficiencies in navigating websites in various sectors from academic to commerce. As an adult educator, PIAAC can provide additional insight on adult proficiency in Internet-based learning. Together, PIAAC and the findings from this study can be used to improve how credible controversial science information is disseminated through online learning platforms. Given the numerous areas in need of continued research on digital competencies and adult science education opportunities, I am highly encouraged by the international research on adult digital literacies in addition to the findings from this current study.

Concluding Comments

Science has become integral in many facets of society and our everyday lives. Science provides homeowners fertilizers and pesticides to help gardens grow. Science has afforded many ways in which we can power our homes and cars. Science provides health to communities through vaccinations, water treatment facilities, and sewage treatment facilities. Science feeds thousands around the world with genetically modified crops and hydroponics. Science allows us to travel around the globe and beyond. Science is amazing and amazingly complex.

However, adults are encountering situations in which they must make meaning and find logic in in controversial, complicated, complex scientific processes, oftentimes without expert guidance. This conflicting science-based information can cause immediate or delayed dissonance. Online science-based resources can influence large scale elections, types of vehicle to purchase, or fertilizer application details. Science information can be used to influence society. Science information can be used to scare society. Having skills to discern credible science-based information from noncredible science-based information can empower adults to save a life or save some money or save a planet. Teaching digital literacy skills, science literacy skills, and information literacy skills through the lens of a lifelong learning approach can equip adults to critically evaluate the credibility of the science-based resources they encounter.

REFERENCES

Association of College & Research Libraries (2000). *Information literacy competency standards for higher education*. American Library Association: Illinois.

Berland, M., Baker, R. S., & Blikstein, P. (2014). Educational data mining and learning analytics: Applications to constructionist research. *Tech Know Learn, 19,* 205-220.

Berry, R. S. (2001). Social Impacts of the Transition. In R.S. Berry and A. S. Moffat (Eds), *The Transition from Paper: Where are we going and how will we get there?* Retrieved from www.amacad.org/content/publications/publication.aspx?d=560

Bonk, C. J. (2010). For openers: How technology is changing school. *Educational Leadership*, p. 60-65

Britt, M. A., Richter, T., & Rouet, J. (2014). Scientific literacy: The role of goal-directed reading and evaluation in understanding scientific information. *Educational Psychologist, 49*(2), 104-122.

Brockett, R. G. & Hiemstra, R. (1991). *Self-direction in adult learning: Perspectives on theory, research and practice.* Rutledge: New York.

Brookfield, S. D. (1983). *Adult learners, adult education and the community.* New York: Teachers College Press.

Butefish, W. L. (1990). Science teachers' perceptions of their interactive decisions. *The Journal of Educational Research*, *84*(2), 107-114.

Calvert, P. J. (2001). Scholarly misconduct and misinformation on the World Wide Web, *The Electronic Library, 19*(4), p. 232-240.

Candy, P. (1991). *Self-directed for lifelong learning.* San Francisco: Jossey-Bass.

Candy, P. (2004). *Linking thinking: Self-directed learning in the digital age.* Research Fellowship Scheme: Australia.

Charmaz, K. (2014). *Constructing grounded theory*. (2nd ed.). Los Angeles: SAGE.

Cooper, E. A., & Farid, H. (2016). Does the sun revolve around the Earth? A comparison between the general public and online survey respondents in basic scientific knowledge. *Public Understanding of Science, 25*(2), 146-153.

Creswell, J. W. (2003). *Research design: Qualitative, quantitative, and mixed methods approaches.* Thousand Oaks: Sage.

Cronin, D. P. & Messemer, J. E. (2013). Elevating adult civic science literacy through a renewed citizen science paradigm. *Adult Learning, 24*(4), 143-150.

Cross, K.P. (1981). *Adults as learners: Increasing participation and facilitating learning*. San Francisco: Jossey-Bass.

Darkenwald, G.G. & Merriam, S.B. (1982). *Adult education: Foundations of practice*. New York: HarperCollins.

DeBoer, G. E. (2000). Scientific literacy: Another look at its historical and contemporary meanings and its relationship to science education reform. *Journal of Research in Science Teaching, 37*(6). Doi:10.1002/1098-2736(200008)37:6

Dewey, J. (1938). *Experience and education.* New York: Kappa Delta Pi.

Dimock, M., Doherty, C., & Keeter, S. (2013). Public's knowledge of science and technology. Pew Research Center for the People and the Press.

Falk, J. H. & Needham, M. D. (2013). Factors contributing to adult knowledge of science and technology. *Journal of Research in Science Teaching. 50*(4), 431-452.

Fear, K. & Donaldson, D. R. (2012). Provenance and credibility in scientific data responses. *Archival Science, 12,* 319-339.

Fogg, B. J., Soohoo, C., Danielson, D.R., Marable, L., Stanford, J., & Tauber, E.R. (2003). *How do users evaluate the credibility of web sites? A study with over 2,500 participants.* Proceedings of DUX2003, Designing for User Experiences.

Fowler, A. (2001). Science and science online. In R.S. Berry & A. S. Moffat (Eds), *The Transition from Paper: Where are we going and how will we get there?* Retrieved from www.amacad.org/content/publications/publication.aspx?d=560

Fraenkel, J. & Wallen, N. (2006). *How to design and evaluate research in education.* Michigan: McGraw-Hill.

Garrison, D. R. (2003). Cognitive presence for effective asynchronous online learning: The role of reflective inquiry, self-direction, and metacognition. *Elements of Quality Online Education: Practice and Direction, 4,* 47-58.

Greenhow, C., Gibbins, T., & Menzer, M. M. (2015). Re-thinking scientific literacy out-of-school: Arguing science issues in a niche Facebook application. *Computers in Human Behavior, 53*(2015), 593-604.

Greer, J.D. (2009). Evaluating credibility of online information: A test of source and advertising influence. *Mass Communication and Society*, *6*(1), 11-28.

Guglielmino, L.M., Long, H.B., & Hiemstra, R. (2004) "Historical perspectives series: Self-direction in learning in the United States", *International Journal of Self-directed Learning*, *1*(1), 1-18.

Halverson, K.L., Siegel, M.A., & Freyermuth, S. K. (2010). Non-science majors' critical evaluation of websites in a biotechnology course. *Journal of Science Education Technology, 19*(6), 612-620.

Hargittai, E. & Shafer, S. (2006). Differences in actual and perceived online skills: The role of gender. *Social Science Quarterly, 87*(2), 432-448.

Hiemstra, R. & Brockett, R. (1994). 'From behaviorism to humanism: Incorporating self-direction in learning concepts into the instructional design process.' H.B. Long and Associates, *New Ideas about Self Directed Learning*. Norman, OK: Oklahoma Research Center for Continuing Professional and Higher Education, University of Oklahoma.

Hilligoss, B, & Rieh, S.Y. (2008). Developing a unifying framework of credibility assessment: Construct, heuristics, and interaction in context. *Science Direct, 44,* 2008, 1467-1484.

Horrigan, J. B. (2016). *Lifelong learning and Technology*. Pew Research Center.

Houle, C.O. (1961) *The Inquiring Mind: A study of the adult who continues to learn*. Madison: The University of Wisconsin Press.

Howard, B., McGee, S., Shia, R. & Hong, N. S. (2001, April). *Computer-based science inquiry: How components of metacognitive self-regulation affect problem-solving.* Paper presented at the Annual Meeting of the American Educational Research Association, Seattle, Washington.

Hughes, B., Wareham, J., & Joshi, I. (2010). Doctors' online information needs, cognitive search strategies, and judgments of information quality and cognitive authority: How predictive judgments introduce bias into cognitive search models. *Journal of the American Society for Information Science and Technology, 61*(3),433-452.

Irving, C. J. & English, L. M. (2011). Community in cyberspace: Gender, social movement, and the Internet. *Adult Education Quarterly, 61*(3), 263-278.

Johnson, T.J. & Kaye, B.K. (2002). Webelievabilty: A path model examining how convenience and reliance predict online credibility. *Journalism and Mass Communication Quarterly*, *79*(3),619-642.

Jones, A. C., Scanlon, E., & Clough, G. (2013). Mobile learning: Two case studies of supporting inquiry learning in informal and semiformal settings. *Computers & Education*, *61*21-32. doi:10.1016/j.compedu.2012.08.008

Karakas, F. & Manisaligil, A. (2012). Reorienting self-directed learning for the creative digital era. *European Journal of Training and Development, 36*(7), 712-731.

Knowles, M.S. (1980). *The modern practice of adult education: From pedagogy to andragogy*. Englewood Cliffs, NJ: Cambridge Adult Education.

Knowles, M.S., Holton, E.F., & Swanson, R.A. (2005). *The adult learner: The definitive classic in adult education and human resource development*, 6th ed. Burlington, Elsevier.

Koro-Ljungberg, M., Douglas, E. P., Therriault, D., Malcolm, Z, & McNeill, N. (2012). Reconceptualizing and decentering think-aloud methodology in qualitative research, *Qualitative Research, 13*(6), 735-753.

Kupper-Textzal (2014). Understanding the Distributed Practice Effect: Strong Effects on Weak Theoretical Grounds. *Zeitschrift fur Psychologie*, 222(2), 71-81.

LeCompte & Preissle (1993). *Ethnography and qualitative design in educational research.* San Diego: Academic Press.

Lederman, R., Fan, H., Smith, S., & Chang, S. (2014). Who can you trust? Credibility assessment in online health forums. *Science Direct, 3*, 13-25.

Lim, S. & Simon, C. (2011). Credibility judgment and verification behavior of college students concerning Wikipedia. *First Monday, 16*(4), 1-20.

Mamary, E. M., & Charles, P. (2000). On-site to on-line: Barriers to the use of computers for continuing education. *The Journal of Continuing Education in the Health Professions, 20,* 171-175.

Mason, J. (2002). *Qualitative researching 2nd Edition.* London: Sage.

Mason, L., Boldrin, A., & Ariasi, N. (2010). Epsitemic metacognition in context: Evaluating and learning online information. *Metacognition Learning, 5*, 67-90.

Matthews, S. C., Camacho, A., Mills, P. J., & Dimsdale, J. E. (2003). The Internet for medical information about cancer: Help or hindrance? *Psychosomatics, 44*(2), 100-103.

Metzger, M. J. (2007). Making sense of credibility on the web: Models for evaluating online information and recommendations for future research. *Journal of the American Society for Information Science and Technology, 58*(1), 2078-2091.

Metzger, M. J., Flanagin, A. J., & Medders, R.B. (2010). Social and heuristic approaches to credibility evaluation online. *Journal of Communications, 60*, 413-439.

Metzger, M. J., Flanagin, A. J., & Zwarum, L. (2003). College student web use, perceptions of information credibility, and verification behavior. *Computers and Education, 41*, 271-290.

Meyers, E. M. (2010). Cognitive authority in everyday life from small worlds to virtual worlds. *Knowledge Quest.* 38(3), 48-51.

Miller, J. D. (Spring 1983). Scientific literacy: A conceptual and empirical review. *Daedalus, 112*(2), 29-48.

Miller, J. D. (1998). The measurement of civic scientific literacy. *Public Understanding of Science, 7*, 203-223.

Miller, J. D. (2010). Adult science learning in the Internet era. *The Curator: Museum Journal*. 53(2), 191-208.

Miller, J. D. (Fall 2012). What colleges and universities need to do to advance civic scientific literacy and preserve American democracy. *Liberal Education,* 28-33

Mo Jang, S. & Kim, J. K. (2018). Third person effects of fake news: Fake news regulation and media literacy interventions. *Computers in Human Behavior,* 80, 295-302.

Mocker, D.W. & Spear, G.E. (1982). Lifelong learning: Formal, nonformal, informal, and self-directed. Informational Series No 241.Columbus: ERIC Clearinghouse on Adult, Career, and Vocational Education, The National Center of Research in Vocational Education, The Ohio State University, ERIC Document Reproduction service No. ED 220 723).

Oakley, N.S. & Daudert, B. (2016). Establishing best practices to improve usefulness and usability of web interfaces providing atmospheric data. *American Meteorological Society*. doi 10.1175/BAMS-D-14-00121.1

Papert, S. & Harel, I. (1991). Situating Constructionism. In I. Harel & S. Papert (Eds). *Constructionism*. Able Publishing Corporation.

Piper, P. S. (2000). Better read that again: Web hoaxes and misinformation. *Searcher, 8*(8), 40-53.

Perrin, A. & Duggan, M. (2015). Americans' internet access: 2000-2015. *Pew Research Center.*

Poynton, T. A. (2005). Computer literacy across the lifespan: A review with implications for educators. *Computers in Human Behavior, 21*, 861-872.

Preissle, J. & Grant, L. (2004). Fieldwork traditions: Ethnography and participant observation. In K. B. DeMarrais & S. D. Lapan (Eds.), *Foundations for research: Methods of inquiry in education and the social sciences* (161-180). Lawrence Erlbaum Associates: New Jersey.

Probst, Y. C., De Agnoli, K., Batterham, M., & Tapsell, L. (2009). Video-recorded participant behaviors: The association between food choices and observation behaviors from a web-based diet history interview. *Journal of Human Nutrition and Dietetics, 22,* 21-28.

Quinney, K. L., Smith, S. D., & Galbraith, Q. (2010). Bridging the gap: Self-directed staff technology training. *Information Technology & Libraries*, *29*(4), 205-213.

Rager, K. (2003). The self-directed learning of women with breast cancer. *Adult Education Quarterly, 53*(4).

Rapchak, M. E., Lewis, L. A., Motyka, J. K., & Balmert, M. (2015). Information literacy and adult learners: Using authentic assessment to determine skill gaps. *Adult Learning,* 26(4), 135-142. DOI: 10.1177/1045159515594155.

Raskin, J. D. (2002). Constructivism in psychology: Personal construct psychology, radical constructivism, and social constructionism. In J. D. Raskins & S.K. Bridges (Eds.), *Studies in meaning: Exploring constructivist psychology* (1-25). Pace University Press: New York.

Ravitch, S. M. & Riggan, M. (2012). *Reason and Rigor.* Thousand Oaks, California: Sage.

Rieh, S. Y. (2002). Judgment of information quality and cognitive author in the web. *Journal of the American Society for Information Science and Technology*. 52(2),145-161.

Rieh, S. Y. & Danielson, D. R. (2007). Credibility: A multidisciplinary framework. In B. Cronin (Ed.), *Annual review of information science and technology*, New Jersey: Information today.

Rieh, S. Y., Y. M. Kim, Yang, J. Y. & St Jean, B. (2010). A diary of credibility assessment in everyday life information activities on the web: Preliminary findings. *Proceedings of the American Society for Information Science and Technology, 47*, 1-10.

Roach, V. & LeMasters, L. (2006). Satisfaction with online learning: A comparative descriptive study. *Journal of Interactive Online Learning, 5*(3), 317-332.

Roberson, D. N.& Merriam, S. B. (2005). The self-directed learning process of older, rural adults. *Adult Education Quarterly, 55*(4), 269-287.

Roulston, K. (2010). Reflective Interviewing: A guide to theory and practice. Los Angeles: Sage.

Rowe (2009). Using video-stimulated recall as a basis for interviews: Some experiences from the field. *Music Education Research*, *11*(4), 425-437.

Saldana, J. (2016). *The coding manual for qualitative researchers*. Los Angeles: Sage.

Scharkow, M. (2016). The accuracy of self-reported Internet use: A validation study using client log data. *Communication Methods and Measures*, 10(1), 13-27.

Schmidt, K.E., Liu, Y., & Sridharan, S. (2009). Webpage aesthetics, performance and usability: Design variables and their effects. *Ergonomics, 52*(6), 631-643. DOI:10.1080/00140130802558995

Schwier, R. A. (2010). Focusing educational technology research on informal learning environments. *Contemporary Educational Technology*, *1*(1), 90-92.

Segev, E. & Barram-Tsabari, A. (2012). Seeking science information online: Data mining Google to better understand the roles of the media and the education system. *Public Understanding of Science, 21*(7), 813-829.

Shen, B. J. (1975). Scientific literacy: Public understanding of science is becoming vitally needed in developing and industrialized countries alike. *American Scientist, 63*(3), 265-268.

Smith, A.G. (1997). Testing the surf: Criteria for evaluating Internet information resources. *The Public-Access Computer Systems Review*, 8(3), 5-23.

Song, L. & Hill, J. R. (2007). A conceptual model for understanding self-directed learning in online environments. *Journal of Interactive Online Learning, 6* (1), 27-42.

Takahashi, B. & Tandoc, Jr., E. C. (2015). Media sources, credibility, and perceptions of science: Learning about how people learn about science. *Public Understanding of Science*, 1-17. DOI: 10.1177/0963662515574986.

Tough, A. (1979). *The adult's learning projects: A fresh approach to theory and practice in adult learning*, 2nd ed. Toronto: Ontario Institute for Studies in Education.

Triese, D., Walsh-Childers, K., Weigold, M.F., & Friedman, M. (2003). Cultivating the science Internet audience: Impact of brand and domain on course credibility for science information. *Science Communication*, *24*(3), 309-332.

Tseng, S. & Fogg, B.J. (1999). Credibility and computing technology. *Communications of the ACM, 42*(5), 39-44.

Warnick, B. (2004). Online ethos: Source credibility in an "authorless" environment. *American Behavioral Scientist, 48*(2), 256-265.

Wathen, C.N. & Burkell, J. (2002). Believe it or not: Factors influencing credibility on the web. *Journal of the American Society for Information Science and Technology, 53*(2), 134-144.

Wiley, J., Goldman, S.R., Graesser, A.C., Sanchez, C.A., Ash, I.K., & Hemmerich, J.A. (2009). Source evaluation, comprehension, and learning in Internet science inquiry tasks. *American Educational Research Journal*, *46*(4), 1060-1106.

Wilson, P. (1983). *Second-hand knowledge: An inquiry into cognitive authority.* Connecticut: Greenwood Press.

APPENDIX A

RECRUITMENT FLYER

Research Participants Needed!

WHO can help?

*Anyone **aged 35-45**, who:*

- *Uses the **Internet** to search for information*
- *Likes learning about new **science** topics*
- *Has **two hours** to volunteer*
- *Lives in the **Savannah** area*
- *Enjoys a treat from **Starbucks***

WHEN is your help needed?

- Anytime during February or March 2017

WHAT is expected of you?

- Participate in a research session that will last about two hours. During the research session, you will be asked to look up science topics on a computer, then talk to me about your Internet search.

For your time,

- You will receive a $25 gift card to Starbucks upon completion of your research session!

If interested, please contact
Angela Bliss, Univ of GA Doctoral Candidate
acbliss@uga.edu or **912-224-0865**

APPENDIX B

INITIAL CONTACT QUESTIONNAIRE

Initial Contact Questionnaire

Participant Name:____

Phone Number: ____

Email Address: ____

Directions: *Ask the following questions. If all criteria for selection are met, then set a session time and date and assign participant a number.*

Participant Demographics:

1- Do they live in Savannah or the Savannah area (such as, Richmond Hill, Garden City, Pooler, Thunderbolt or Tybee Island)?

2- Current job title:

3- High School Graduate/GED data:

4- Do they have a degree in the sciences?

5- Have they searched for information on a computer?

6- Have they conducted information searches on the Internet?

7- Are they interested in learning about: Climate Change? Hydraulic fracking?

8- Do they have transportation to Skidaway Island?

9- Do they have approx. 2 hours to volunteer one day in Feb or March 2017?

SESSION TIME: ______________________ Participant #:____________

SESSION DATE: _____________________

Be sure to thank them for their time and
remind them of the $25 gift card after the session is complete.

APPENDIX C

PRELIMINARY PILOT OVERVIEW

Preliminary Pilot Overview

Research session protocol afforded several variables in technology, location, and topic. To gain perspective on these variables, field tests and an expert review was conducted before research sessions were conducted. Two field tests were conducted on location using a laptop, my personal Hewlett Packard, and the newly acquired Camtasia Studio 8 software. The single expert focused on science content in prompts. The following section discusses the objectives, processes, and lessons learned through these exploratory trials.

Goals and Objectives of the Field Tests and Expert Review

The main goals of the two field tests and expert review were to gain experience with the newly acquired screen capture software, Camtasia Studio 8, and modify the research session protocol from theoretical- based to practice-based. The two field test participants and one expert review participant were selected out of convenience and none met the primary qualification criteria for participating in the actual research study as all three participants were classified as science experts.

The expert review was conducted offsite, but both field tests were conducted at the proposed research location and on the proposed research laptop which allowed me to experience the overall research session flow and the computer/participant interface. The field tests were formative as modifications were made after the first field test and, then as needed, further modifications were made after the second field test. The expert review guided subject matter selection for the computer search prompts. Table 15, listed below, details the objectives for each stage of the pilot process. The seven objectives used to guide the field tests and expert review sessions are discussed in the following section along with details on the processes and lessons learned.

Table 65. Objectives for Pilots

Objectives for Pilots	Field Test 1	Field Test 2	Expert Review
1. Test Internet connectivity	X		
2. Evaluate space at the proposed research location	X		
3. Practice using data collection software	X	X	
4. Resolve computer prompt format	X	X	X
5. Practice interviewing with video	X	X	
6. Evaluate time needed per session	X	X	
7. Collect data to guide data analysis protocols.	X	X	

Field Test One

The first field test provided initial experiences in the seven objectives along with constructive feedback and session alteration considerations for the second field test regarding the seven objectives. The first participant was a research scientist who met all other research criteria. I refer to this participant as "James."

Objectives. Field test one provided baseline data on the proposed procedures that had been selected based on literature, prior experiences, and discussions with Major Advisor and Methodologist. Details on the influence of the first field test on the initial seven objectives are discussed below. Discussion also includes support for the modifications made before Field Test Two.

Objective One: Test Internet connectivity. In past experiences, many meetings and online searches have been disrupted or terminated due to poor Internet connectivity or loss of Internet signal. For this research to be conducted, I had to ensure a strong signal capable of sustaining connectivity through a prolonged Internet search. Field test one pulled an Internet signal for a sustained amount of time without any problems. Participant did not have issue with Internet response speed or signal strength for the 42-minute search.

Lessons learned. The fiber optic cables performed excellently during the sustained Internet search. So, barring any unforeseen outage, the speed and signal strength of the Internet at this proposed location was acceptable for research session expectations. However, interest in personal files on my desktop indicated that I need to visually declutter this space as James indicated it was distracting to find the Internet browsing icons. Also, it came to light that the web browser was selected because of its position on my laptop. So, I will provide several web browsing options for research participants to select.

Objective Two: Evaluate space at the proposed research location. The proposed research session location was thought to be an ideal quiet place to have research participants conduct extended Internet searches and the follow up interviews. It is a two-story building with a large conference room on the second floor and restrooms on the first floor. The building is situated alongside the Skidaway River providing a beautiful area should participants choose to take a break during the research session. Also, parking is convenient and free which will alleviate parking concerns participants might face elsewhere in Savannah.

Lessons learned. Field Test One confirmed the conference room was of adequate size for the participant to have personal space during their research session. The chairs were comfortable for the one to two hour proposed research time and a restroom was nearby if needed. Additionally, the temperature was comfortable, the room was quiet, and there was a separate room that allowed me to sit while the participant worked on the Internet search portion of the research session. The one issue with the space was the conference room door. In entering and exiting the room, it made a loud jarring sound as it closed. So, I must either stay in the room during the research session, or let the participant come get me when they finish to prevent disturbing the participants.

Objective Three: Practice using data collection software. Field Test One afforded the initial opportunity of experimenting with Camtasia Studio 8, by TechSmith, not only in how to use it, but in how to manipulate the data and the occurrence of any laptop performance issues from the large software package. During this field test, I recorded a screen capture video of the participant's entire Internet search and audio/video recorded the following interview session. This method yielded two video files, one of the search and the other of the interview while watching the search. This should prevent the arduous task of having to sync audio and video files.

Lessons learned. Camtasia Studio 8 is a large software package and caused problems for my older laptop. Project files produced through Camtasia Studio 8 are very large and require a powerful processor with a higher end video card. This computer limitation came to light as James was interrupted several times with screen resolution prompts followed by an unexpected web browser termination. I have purchased a faster new laptop to prevent these technical issues during data collection.

Objective Four: Resolve computer prompt format. Research in online behavior has historically been self-reported or based in quantitative methodologies such as surveys. Literature to date has not been found to suggest a best practice on a qualitative approach to these computer prompts. So, decisions had to be made: was it best to ask participants to research science-based tasks, ask participants to answer one lined science-based questions, or ask participants to research science-based statements to find supporting arguments on their position.

For this initial field test, I elected to have participants respond to a controversial science-based statement as this approach seemed more casual. I thought this format maintained a relaxed self-directed informal learning characteristic while minimizing anxiety perceived from performance expectations. Secondly, from writing and rewriting lengthier tasks from previous methodology drafts, a more simplified statement reduces bias that might be introduced from supplied or omitted background information. Lastly, readability level of the computer prompts should not overly task the participants. So again, a more simplified statement seemed to meet a wider range of reading skills.

Other than format of statement versus task versus question, literature has not been found to guide the number of computer prompts or the time allotment for the computer session or how the computer prompts should be presented. For this initial field test, five science-based statements were typed on a piece of copy paper and placed by the computer. Order of how the participant responded to the computer prompts could be implied by the ordering of the items on the paper, but the participant could have responded to the items in varied ways since all items were presented at one time.

Lessons learned. The computer prompts need to be written in question form. Agreeing or disagreeing with a statement did not yield the interaction that I was expecting. Additionally, I had assumed that the topics of the statements were in pop culture or the media in such a capacity that participants possess current feelings swaying them one way or another in response to each statement. This was not the case as James seemed unsure of how to respond when not presented with a question. Expectations of responses needs to be clarified. Asking a question and receiving a response seems a natural way to clarify expectations and does not assume that a participant already claims a position on the topic.

Objective Five: Practice interviewing with video. The screen capture video of the participant's computer prompt session guides the follow-on interview. This field test offered a firsthand experience in interviewing a participant based on their prior actions that were being played on the monitor for us to watch and discuss. Additionally, this first field test offered experiences in how the participant used the software for starting and stopping the video playback.

Lessons learned. While we watched the video, James was probed on why he selected certain sources over other sources. The software allows easy stop and start in the playback in addition to recording the audio and screen movements during the interview. This was great news as all audio and video are synced for analysis. Excited about the software capabilities, I realized after the interview was over that I had started and stopped the video to guide discussion, not the participant.

Objective Six: Evaluate time needed per session. This field test allowed resolution on time. To this point I was unsure of how much time participants needed to search for responses to the computer prompts and how much time to offer as a break before the interview. In this field test, five prompts were selected. No literature to date has offered up the ideal number for such a computer-based qualitative research method. So, five was selected arbitrarily as three seemed too few and ten seemed too many. Five prompts still seemed too numerous for the data I am collecting, so I have decided to reduce the prompts to two or three.

As for time allotted for the computer prompts, this field test participant was not given a time. I simply stated, "take as long as you need to respond to each statement." I also let the participant know that I check in on him in five to ten minutes. He could come get me in the neighboring office space should he finish before I returned. Once the length computer session had ended, I asked if the participant needed a break and he opted for a quick restroom break. He returned in 15-20 minutes. Lastly, I assumed that the interview takes the same amount of time as the computer prompt session.

Lessons learned. James' search lasted approximately 43 minutes. Most of his time was spent reading resources, but there were search decisions made that could be discussed. He spent most of the time researching the DDT/zika statement as it was of most interest to him. However, he had spent time on all five statements. He indicated that he had gotten bored with the computer session, so I think a shortened search time for research participants would be equally rewarding in addition to asking them to search for fewer items on the computer. Also, allowing the participants to take a five to ten minutes break between the computer session and the interview session as I had performed all tasks necessary. The interview took as much time as the search and I will need to remain aware of prompts that keep participants focused back on the research focus.

Objective Seven: Collect data to determine data analysis protocols. New to Camtasia Studio 8, I needed to experience this software's capability in data collection. The software collects all screen movement in a screen capture video in addition to all audio that is played through the computer or spoken while the screen capture video is recording. Additionally, this software recorded the interview sessions (audio and screen) to capture the interview and the screen movements during the video playback.

Lessons learned. The software was a great tool to capture video and audio data. The video data can be paused and rewound for analysis and discussion. The audio can be captured during the initial search as well as the interview with the video playback in the background. This proved helpful during the transcription phase.

Process. The process of field test one provided constructive input on the initial computer prompts. To prevent the distributed practice effect (Kupper-Textzal, 2014), prompts were all given at one time with one follow up interview session conducted once the participant had finished and video replay. Field Test Two is conducted in the same manner to have minimal interruption to the participant's search process.

Field Test Two Overview

The participant for field test two was not a parent but is within the targeted age range of adults for this study and had helped many students with science project inquiries. Also, as with field test participant one, this participant is also considered an expert given his science-based career choice. For the sake of anonymity, this participant is referred to as Ricky.

Objectives. Field test two afforded the chance to test minor changes made after Field Test One while providing more feedback on the seven objectives. In the second field test, I practiced using the data collection software, worked to resolve computer prompt issues, practiced interview protocols, field tested session time, and collected data to determine analysis protocols.

Field test two was presented with a 30-minute time for the computer search portion. I did extend longer time if needed. In discussing this time frame later, the participant admittingly parsed out his time so that each prompt received equal time.

However, in the time stamps on the video of his actual search time, this is not the case as the participant spent two-thirds of his time on the first question.

Lessons learned. I continue to spend time with this software as I merged project files unintentionally. This is a powerful data collection tool that is complicated and having test files to manipulate has proved valuable. As with the first field test, the volume of the interview was acceptable, so I do not need an external microphone. Further research on the prompts determined that five prompts are too many and a statement was not the correct format for this portion of the session. Ricky seemed confused on my expectations in prompt responses and was uncertain with how to initiate the Internet search. Reducing prompts to two or three and altering form from statement to question is a must. Also, shifting the format to asking participants to research a question so that they can enter a discussion with me about their answer is meant to engage them on a different level of learning and accountability.

Unlike the first field test, I allowed the second field test participant to physically control the playback, talking through his search behavior and stopping the video playback when necessary. For decisions in which he did not stop, but I felt a decision had been made, I asked him to pause and prompted him with questions such as "Why did you select that entry or skim over that entry?". I am concerned of sounding like a broken record in perpetually probing the participant during this time, but the participant may catch on to what information is needed at each decision point.

Process. Field test two had a more fluid feel with smoother transitions. Also, this field test provided an opportunity for the participant to lead the post computer session interview. By having the participant talk through their thinking, I felt that they could predict the decision points much more efficiently than I could. As for a fluid transition between the computer session and the post computer session interview, a rest room break of five to ten minutes is adequate. The field tests have been valuable to forming my research methodologies as they provided familiarity with the research location and data collection technology thus strengthening confidence.

Expert Review

Once the field tests were complete, I reflected on the experiences and sorted through my notes and the project files. After narrowing down the five prompts to two and rewriting them as questions, I asked a science expert to review the question for clarity and accuracy. The expert reviewer read over the revised computer questions to ensure clarity. Also, this expert was asked to critique the questions clarity and offer suggestions on content based on what science is present in the news as I want to ensure those without a science background are somewhat familiar with the selected content areas. The expert reviewer improved wording to prevent misinterpretation of a question and vetted the remaining two questions as socially salient science topics.

APPENDIX D

CONSENT FORM

CONSENT FORM

I, ______________________________, agree to take part in a study entitled Exploring How Adults Identify Credible Science Information on the Internet which is being conducted by Angela C. Bliss, Department of Adult Education,
The University of Georgia, (912) 224-0865, under the direction of Dr. Thomas Valentine, Department of Adult Education, The University of Georgia, (706) 542-4017.

The reason for the study is to evaluate the criteria adults use to determine the credibility of science information found online.

I do not have to participate in this study if I do not want to; I understand that I can stop my participation at any time for any reason without any negative consequences.

I am volunteering for this research and understand there are two parts requiring my assistance. In completing both parts of the research session (the computer research session and the following interview session), I will be offered an appreciation gift (a $25 gift card to Starbucks). I do not have to accept the gift card.

I understand that during this research, my Internet search and voice will be recorded via a screen capture software program (TechSmith Camtasia Studio 8) and an audio recorder. My likeness will not be recorded and no image of me will be associated with this research.

No discomforts or stresses are expected. No risks are expected.

Data from this study will be confidential and my identity will not be publicized to any third party unless otherwise required by law. The audio and video files will be destroyed upon graduation, May 2018. The data from this study may appear in a published study, but names will not be disclosed; pseudonyms will be used in referring to all participants.

The researcher will answer any further questions about the research, now or at any time during the project. She can be reached at (912) 224-0865.

My signature below indicates that the researcher has answered all questions to my satisfaction and that I consent to volunteer for this study. I have been given a copy of this form.

________________________________ ________________________________

Signature of Researcher/Date Signature of Participant

Additional questions or problems regarding your rights as a research participant should be addressed to Chris A Joseph, Ph.D., Human Subjects Office, University of Georgia, 606A Boyd Graduate Studies Research Center, Athens, Georgia 30602-7411; Telephone (706) 542-3199; E-Mail Address: IRB@uga.edu.

APPENDIX E

COMPUTER SESSION QUESTION SHEET

Computer Session Question Sheet

Directions:

Please take about 30 minutes to look up the following questions on the Internet. Use any online source(s) to determine your answer. When you finish, we will go over the answers you found.

Questions:

1- What is meant by "fracking" and why are some individuals concerned about this process?

2- What is the leading cause of climate change?

Thanks again for your time and assistance in my research project. – Angela

APPENDIX F

INTERVIEW GUIDE

Interview Guide

Research Questions

1- How do non-science experts define credible science information? (CONSTRUCT)

2- What general rules and cues do participants use to evaluate credible science-based websites during an online search? (HEURISTICS)

3- What criteria do participants assign to credible science-based information found online? (INTERACTION)

Interview Questions:

(Start new Camtasia recording file to include original computer search file and stimulated recall interview audio)

Me: Thank you again for taking the time today to spend with me on my research project.

As mentioned when we first met, I am interested in what adults learn online, specifically what science information adults learn online. To finish up our time today, I'd like to take a few moments, and have you walk me through your computer search session. As we talk about your search, I'm interested in why you made your decisions, so please be sure to tell me why you selected or didn't select certain pages. Pressing these buttons allow you to stop and restart video, please feel free to stop/start as often as necessary to tell me what you were thinking at that time.

Me: As you prepared to search for science-based resources to answer these questions, can you briefly tell me how you approached the large amount of information on the Internet to make sure the information you used in your answer was credible? (RESEARCH QUESTION #1)

Participant: ***ANSWERS VARIES***

Me: I'm going to start the playback of your computer search session. Please talk me through your selection process and pause the video at each decision point to tell me as much detail to what you were thinking about the resources in front of you. No detail is too small for you to include and there is no right or wrong answer for the decisions you made. If I have any questions, I can pause the video as well, but I would like you to be the primary talker through this journey to revisit your Internet searches. So, let's get started as I can't wait to hear about the resources you found and why you selected them to help formulate the answer to the questions. *(PUSH PLAY.)*

I noticed you selected ______ as the search engine to begin this search. Is this normally the search engine you select for internet searches? For science-based searches?

Participant: Talking through search.

Me: Prompts and questions to probe into their thinking as they make evaluation and judgment decisions:

1. On this page, what resources did you consider? (RESEACH QUESTION #2)
2. What influenced your decision in selecting/ avoiding that resource? (RESEACH QUESTION #2)
3. Were you familiar with the webpage/source/agency *(whatever term fits best at the time)* that you selected/avoided? Please tell me more. (RESEARCH QUESTION #3)
4. I noticed that you hesitated before deciding between X & Y, can you tell me more about your thoughts here? (RESEACH QUESTION #3)

5. It seems you quickly navigated away/to Z page, what helped you make such a quick decision? (RESEACH QUESTION #3)
    a. For example, what had you noticed in scanning the page?
6. In searching for the answer to Question 1 on fracking, how did you determine when you had found believable or “credible” information? (RESEACH QUESTION #3)
    a. Can you provide specific examples from today’s search?
7. Same question regarding the second search on climate change, how did you determine when you had found believable or credible information? (RESEACH QUESTION #3)
    a. Can you provide specific example from today’s search?
8. In today’s search of online science information, what were a couple reasons that made you feel confident in the credible sources that you selected? (RESEACH QUESTION #2)
9. Have you looked online for fracking information before? (RESEACH QUESTION #1)
10. Had you looked online for climate change information before? (RESEARCH QUESTION #1)
11. Were you familiar with the fracking or climate change before your computer search today?
    a. Please tell me more about your prior learning experiences with fracking.

b. Please tell me more about your prior learning experience with climate change.

12. Is there anything that you would like to add?