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DECODING A NEW AGE OF INFORMAL LEARNING:

DESCRIBING PUBLIC PEDAGOGY FOR THE WEB

by

Alison Anderson Holland

A dissertation submitted in partial fulfillment of the requirements for the degree of Doctorate in Education

Hamline University

Saint Paul, Minnesota

December 2018

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ABSTRACT

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The everyday, informal, out-of-school learning adults participate in has drastically changed in the past two decades as information and interaction online has grown and evolved (Blaschke, 2012; Skyrme, 2001). Instead of attending in-person workshops and noncredit courses, sending away for fact sheets and the like, much informal learning today occurs online, often beginning with a search engine or social network. However, long-standing, nonprofit, and governmental institutions have largely failed to understand and capitalize on the new information and education ecosystem, while nimble start-ups (e.g., Wikipedia) have thrived (Fuad-Luke, 2009; Skyrme, 2001). This dissertation aims to provide a model for a pedagogical approach to the design and evaluation of public websites that will support the vision and understanding needed to move forward more successfully in this complex and quickly evolving work (Sandlin, Schultz, & Burdick, 2010). I have chosen a collective case study methodology to explore the educational content and platform design and outcome evaluation strategies employed by the organizations, and in doing so, to illustrate public pedagogy for the web for a wide variety of possible applications. The study identified that website and content design is focused on storytelling and curation for the curious public. Furthermore, social media sharing of educational content fosters organic, pop-up communities of inquiry around discrete topics. Lastly, it was determined that the development of evaluation best practices to measure learning outcomes and effectiveness of website and social media content is both needed and desired by practitioners in the field. (241 words)

DEDICATION

To Jeff, who lovingly supports the pursuit of my goals without question.
To our daughters, who reluctantly share me with my academic and professional passions.
To our family and friends, who have supported them in my absence.
To my cohort and faculty, who remind me motherhood and womanhood are strengthened by doing rather than regretting. I could not be more grateful to my "village."

To the interviewees, without whom this study would not have been possible.
Your insights are invaluable;
I would be honored and grateful to work with you on future projects.

"Almost always the men who achieve these fundamental inventions of a new paradigm have been either very young or very new to the field whose paradigm they change."

Thomas Kuhn, *The Structure of Scientific Revolutions*

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Editing was provided by Megan Krone, PhD, Director of Academic Coaching and Editing at Heartful Editor, and Sara Kathleen Henry, PhD, Founder and Editor-in-Chief.

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CHAPTER ONE

The future is already here—it's just not very evenly distributed.

William Gibson (as cited in Ito & Howe, 2016, p. 23)

The Problem

Gone are the days when in-person workshops and phone calls were primary modes of out-of-school learning. With Google, YouTube, and lightning-speed access to our 300 closest friends and thousands of strangers in the palm of our hands, organizations that seek to share scientific knowledge to inspire learning that improves lives and/or informs policies need to modernize their delivery methods or risk going the way of the dinosaurs. Although tacit and intentional learning happens informally online all the time, the literature does not yet adequately address the internet as a space for learning outside course structures. Scientific organizations with missions that include educating the public outside of school settings will need to understand how the Internet is used to learn, through both self-directed and incidental learning. A successful democracy requires informed citizens. Therefore, this dissertation explores the evolution of the Internet as a tool for informal, self-directed learning with a public pedagogy lens. It paints a picture of online educational design strategies that organizations would be wise to employ and identifies methods that can be used to measure learning and behavior change, or personal behavior modification, outcomes that result from the new strategies described.

Background

The 1914 Smith Lever Act established a national system of cooperative extension (Extension) “to bring people the benefits of current developments in the field of agriculture, home economics, and other related subjects” (Comer, Campbell, Edwards, & Hillison, 2006, para. 1). This formalized the pre-existing practice of schools and colleges

of agriculture hosting community meetings, lectures, and demonstrations of new practices (Comer et al., 2006). Extension organizations in each state have since expanded their topic bases and continue to share evidence-based information with the people of their states to improve lives and communities. Public agencies, such as the National Oceanic and Atmospheric Agency (NOAA), the National Aeronautics and Space Administration (NASA), the U.S. Department of Agriculture (USDA), the Food and Drug Administration (FDA), and the Centers for Disease Control (CDC), also share scientific information with the public to improve and protect the lives of citizens. Science museums share evidence-based information with the public with missions related to improving lives through new practices, often with a longer range view on outcomes than colleges of extension and public agencies. This practice of sharing scientific information with the public to support positive behavior and policy change is outreach education.

Outreach education must evolve for today's technological reality, with platforms and devices designed for mobile multidirectional communication, collaboration, and user-generated content (Rollett, Lux, Strohmaier, Dösinger, & Tochtermann, 2007). Less reputable organizations with more immediate financial incentives to get eyeballs on their content have evolved more quickly and have largely left legacy scientific outreach organizations behind (Fuad-Luke, 2009; Skyrme, 2001). As of January 2018, 77% of Americans over age 18 reported owning a smartphone (Pew Research Center, 2018a). At the same time, 68% of adults actively use Facebook, and 73% actively use YouTube (Pew Research Center, 2018b). Therefore, it is important to conceptualize and design public websites pedagogically (Sandlin, Schultz, & Burdick, 2010). User-centered design can be an effective tool to support engagement and learning; it can "enhance the effectiveness of communication, increasing the capacity of the recipient to engage with

the information and learn from the communication" (Kelly, 2015, p. 393). Like museums do with physical spaces, online outreach education must not only consider the design of the educational content they create and share, but also the structural and functional design of the website and the human resources behind it, to enable the activities that will allow for the most effective learning environment possible.

Loritz, Senior Fellow and President at the Center for Policy Design, asserted, "Children and young adults, between ages 5 and 18, spend much more time out of school than in school. Depending on which state it ranges from 85 to 88% time not in school" (personal communication, October 20, 2016). Taking that further, by mid-adulthood, the average time spent in formal education over one's lifetime is miniscule. Today, we are living in a time when many Americans believe *alternative facts*, a term coined by Conway (2017) and described by others as falsehoods. We are also facing increasing public distrust and diminishing perceived value of higher education (Schleifer & Silliman, 2016). Therefore, there is a need to find new ways to provide research-based educational information that can lead to positive behavior and/or policy change. To facilitate learning in the online ecosystem of information and learning, researchers and outreach organizations need to consider ways to strategically disseminate research findings in the online environment in ways that allow audiences to be as receptive to learning as possible, even if they are not seeking information. Traditional companies and legacy companies have largely been left behind the curve after the emergence of the Internet, then user-centered design, carefully crafted design activism, and co-creation models (Fuad-Luke, 2009; Skyrme, 2001).

Problem Statement

While there is a breadth of research on how to engage online learners in traditional online courses, the literature does not adequately address the Internet as a means of content delivery and engagement that can lead to informal learning in daily life (Carr, 2000; Parker, 1999; Patterson & McFadden, 2009; Sefton-Green, 2004). With decreasing public trust in higher education and increasing use of online media, it will be important for public institutions aiming to educate those outside of school to understand how to effectively use today's online ecosystem (Pew Research Center, 2018a, 2018b; Schleifer & Silliman, 2016). Our ability to increase the knowledge of the citizenry depends on it.

Anderson (2008) developed a model of the interaction and content variables present in independent learning (see Figure 1). This model illustrates how teachers and learners interact with each other and with the content in various directions "using a variety of net-based synchronous and asynchronous (video, audio computer conferencing, chats, or virtual world) interactions" (Anderson, 2008, p. 60). We also know learning resources include a variety of tools (i.e., search functionality, tutorials, simulations, games, virtual labs, and e-books; Anderson, 2008). We do not know, however, the direction and magnitude of each variable's effect on relevant outcomes (Anderson, 2008).

Researchers want us to understand the effect of learning environment variables on outcomes (Anderson, 2008; Starasts, 2015). By knowing more about the learning process and potential learning outcomes within web-based spaces, researchers believe we can increase the effectiveness of learning resources (Heo & Lee, 2013). Anderson (2008) encouraged further development of a theory of online learning, while Sandlin et al. (2010) encouraged further empiricism in developing the field of public pedagogy. Lin

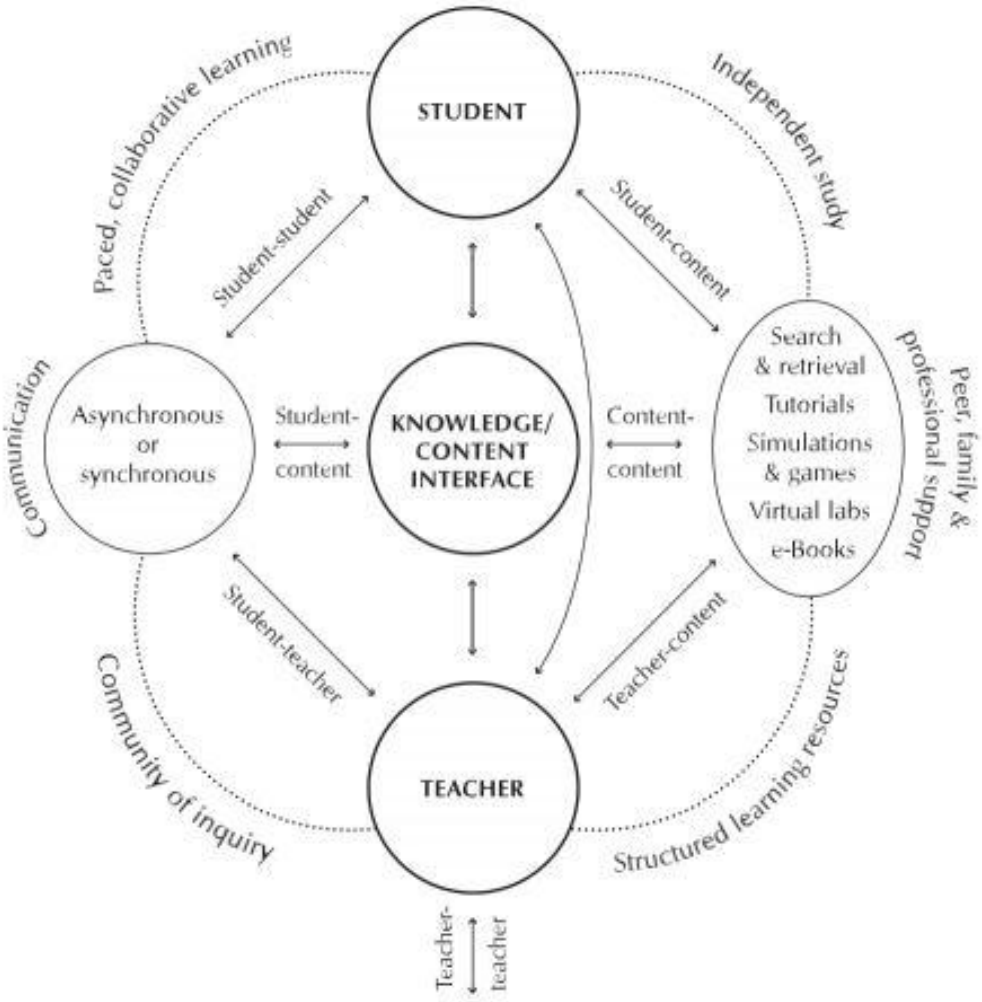

Figure 1. A model of online learning (Anderson, 2008, p. 61).

and Gregor's (2006) exploratory study identified "features for encouraging online learning for enjoyment" and "development guidelines for designing learning for enjoyment" (p. 10) in the context of museum websites from the perspective of museum and educational experts in Taiwan, but given the limited scope, suggested a need to continue the work.

Statement of Purpose

The purpose of this qualitative case study is to examine the pedagogy of the digital content strategy used by scientific outreach organizations in 2018. In this study, I plan to explore how public websites—defined as being discoverable online, not requiring

a fee-based membership, and freely providing information and educational resources for personal use—can be designed pedagogically for informal, self-directed adult learning. The case studies also sought to identify metrics used to measure the impact of these websites in terms of learning outcomes and behavior change (Hoffmann & Koch, 1998).

Research Questions

My overarching research question is: How do scientific outreach organizations think about and implement a version of public pedagogy online? To get to this answer, I planned to investigate the following research subquestions:

1. How are public websites designed to serve as learning spaces for informal, self-directed adult learning?
2. What metrics are used to evaluate learning and behavior-change associated with public websites?

Public Pedagogy

According to Sandlin et al. (2010), "The term public pedagogy first appeared in 1894" (p. 1). It is a theoretical construct used to study the processes and sites of education beyond formal schooling (Sandlin et al., 2010). Public pedagogy grew in popularity in the mid-1990s when it came into favor by feminist and critical theorists (Sandlin et al., 2010). Sandlin et al. (2010) acknowledged the inclusion of the Internet in the field of public pedagogy, alongside popular culture and physical public spaces like museums, parks, and the like. There are studies looking at digital literacy (Trifonas, 2010), video games (Hayes & Gee, 2010), and social media (Reid, 2010) as spaces of public pedagogy; however, there is a gap in educational research looking at outreach education on the web with a theoretical lens of public pedagogy. This study used public pedagogy

as a theoretical construct to understand the ways in which public websites can be designed to support informal learning.

Definitions of Key Terms

The following key terms provide important context for the study overall and are presented in alphabetical order rather than attempting to prescribe an order of importance. Behavior change, constructivism, design, disciplinary matrix, effective, engagement, heutagogy, informal learning, legacy institutions, outreach education, and pedagogy are defined next.

Behavior change. Behavior change is understood by behavioral scientists as an intentional process that involves "progression through five stages—precontemplation, contemplation, preparation, action, and maintenance" (Prochaska, DiClemente, & Norcross, 1992, p. 1). Lown and Nelson (2012) explained, "While increased knowledge is often considered the end goal of an educational program, this is an example of a short-term result. Actions and behavior change are medium-term impacts" (p. 14). The long-term impact of an effective educational program is an improved quality of life by some measure, which can be difficult to pin down (Lown & Nelson, 2012). This study did not measure this, but rather looked for examples of organizations that may be.

Constructivism. A traditional learning experience, whether in a classroom or MOCC, is teacher-centered. Students or audience members passively receive information. Constructivist learning, on the other hand, emphasizes big concepts and focuses learning around questions. Learners are active in the experience, and there is not an expectation that the teacher or presenter has all of the answers. According to the recent report from the Massachusetts Institute of Technology's Online Education Policy Initiative, the term *active learning* grew out of constructivism, which is described in the

report as “an approach first espoused by John Dewey as experiential learning, and formalized by seminal education researchers including Jean Piaget, Maria Montessori, and Lev Vygotsky” (Willcox, Sarma, & Lippel, 2016, p. 6). *Discovery learning*, the report continued, “is a broad approach in which students use inquiry and discovery to construct knowledge” (Willcox et al., 2016, p. 6).

Design. Design is often underrecognized but is prevalent across many areas of ones’ life, embedded across subject and discipline areas (Faud-Luke, 2009). Kelly (2015) explained, “The strong connection between visual communication design and learning” (p. 393) is perhaps most clearly identifiable in museums, “where design strategies are recognised as essential to creating engaging visitor experiences” (p. 393). Informal, free-choice learning makes design practices all the more critical, though they are sometimes difficult to detect (Kelly, 2015). Design is a flexible term that means different things in different disciplines. This study defined design as Ralph and Wand’s (2009) literature-informed proposal did:

> *(noun)* a *specification* of an *object*, manifested by some *agent*, intended to accomplish *goals*, in a particular *environment*, using a set of *primitive components*, satisfying a set of *requirements*, subject to some *constraints*; (*verb, transitive*) to create a design, in an environment (where the designer operates). (p. 108, emphasis added)

Primitives, in this case, are used to define the components or resources that can be used to create a *designed* object (Ralph & Want, 2009). The design of learning websites, for example, can include specifying elements that support appealing content, novelty, credibility, ease of understanding, uniqueness, and emotional impact (Lin & Gregor, 2006).

Disciplinary matrix. A disciplinary matrix is a framework within which a community of researchers work. It was initially described by Kuhn (2015) as paradigm in his book, *The Structure of Scientific Revolutions*, originally published in 1962. Ellenbogen, Luke, and Dierking (2004) later used Kuhn's theory, defining three primary elements of the disciplinary matrix: (a) theory, (b) methodology, and (c) research foci. Ellenbogen et al. (2004) described the theoretical perspective as being signaled by a "shared language, beliefs, values, understandings, and assumptions" (p. 49), the methodologies being "driven by underlying assumptions" (p. 49) about research in the area, and the alignment of research foci. The alignment of theory, methodology, and research foci can indicate the existence of an emerging or discrete discipline.

Effective. This study used the term effective to describe something that supports growth in understanding, skill development, and/or "the application of knowledge and skills" (Litzinger, Lattuca, Hadgraft, & Newstetter, 2011, p. 126) in the real world.

Engagement. Kelly (2015) described design as being responsible to attract, seduce, and engage learners. Engagement is the entryway to learning. Spaces that are relevant and appealing to visitors "increase the effectiveness of learning" (Kelly, 2015, p. 401). When someone is engaged in learning, their attention is captured.

Heutagogy. In 2000, Hase and Kenyon defined heutagogy, as the study of self-determined learning (as cited in Blaschke, 2012). Heutagogy is much like andragogy, but learners are more autonomous and need less direct structure from educators to achieve meaningful learning outcomes.

Informal learning. Informal learning is defined as being unstructured learning in daily life (Merriam, Caffarella, & Baumgartner, 2007). Informal learning is so embedded

in our daily activities that it often goes unrecognized as problems are solved and knowledge is built upon (Merriam et al., 2007).

Legacy institutions. For the purposes of this dissertation, legacy institutions are defined as decades-old organizations with public-good missions, such as the outreach work of public universities (i.e., colleges of extension), long-standing museums, government agencies with outreach components, and the like. They tend to have highly structured policies, traditional practices, and are often accountable to public funding sources.

Outreach education. For the purposes of this dissertation, outreach education, or educational outreach, is defined as programing with a goal of sharing scientific information with the public. Furthermore, the mission of outreach education is to educate in a way that supports positive behavior and/or policy change, thereby improving lives.

Pedagogy. Hickey-Moody, Savage, and Windle (2010) explained that pedagogy can be found in classrooms as traditionally sequenced elements of teaching, or more abstractly in nonformal settings. In any case, pedagogy is the practice of "teaching of some new practice or knowledge to learners" (Hickey-Moody et al., 2010, p. 232). This includes pedagogical intent, substance (i.e., curriculum or content), and process (e.g., the engagement of learners with the content; Hickey-Moody et al., 2010).

Overview of Methodology

This study used a collective, netnographic, case-study approach in an effort to answer the research questions. Netnography is a research method iterated from ethnography, specifically for understanding online contexts (Kozinets, 2015). Organizations were selected for the case study through an online review of nonprofit and government agency websites. The case study included interviews, online observation, and

document analysis. Lastly, I engaged in the websites studied as a participant observer, authentically consuming and interacting with the information and participants and recording my observations in a field notes spreadsheet with coding themes identified through the next chapter's review of literature.

Researcher's Experiences

In the summer of 2015, I began my position as an academic technologist for the University of Minnesota Extension's Technology Department (Extension). Extension is the outreach arm of the university, working to bring the university's research and resources to the people of Minnesota. In other words, Extension connects communities with the latest knowledge the university has on important issues and connects faculty members with communities to further develop their understanding of critical issues through action research. Topics include, but are not limited to, food safety and access, youth and community development, sustainable farming and environmental practices, and parenting and financial decisions for families (University of Minnesota Extension, 2018). In my role, I was tasked with promoting and supporting academic technologies for teaching and learning by Extension faculty and staff. Nearly everyone to whom I spoke in the organization in my first year was troubled by the low completion rates in their online courses.

Coursera co-founder, Daphne Koller (2012), spoke at TED about the extensive reach of their massive open online courses (MOOCs) with enrollees across the world. She spoke about learning from watching students learn and fail in patterns. Instructors modified their strategies to more effectively teach the content. What she did not speak to is the miniscule completion rates in MOOCs (Friedman, 2014; Harasim, 2017). I thought for a while about the fact that perhaps we were measuring the wrong things. Maybe

completion did not matter; maybe the students learned what they wanted. Many students come to content without a need to complete anything. There is no significant reason for them to finish, other than intrinsic motivation. Perhaps students come to get what they need, such as a resource or a skill, find it, and leave. Gathering data from participants who drop out of studies is challenging and elicits at best anecdotal information from which to confirm or negate the idea that they gained what they came for and moved on. If they did, perhaps that is success. However, that is not really the purpose of a course, and the structure is not well-designed to allow for this ebb and flow without hindering other students' experiences.

Impact of experiences on research topic. The conundrum around how to develop knowledgeable citizens and decision-makers through evidence-based research dissemination led me to wonder how we can harness the understandings of multiple disciplines to develop effective research dissemination methods to support evidence-based decision making. My professional and academic backgrounds include newspaper writing, marketing, copywriting, outreach, and public health education work around policy, systems, environmental change, and education design. I believe there is some piece of the answer at the intersection of marketing or outreach strategy and learning and behavior change theories.

Summary

This chapter has introduced the dissertation topic, understanding how scientific outreach organizations be effectively positioned in the online learning and information ecosystem, then gave background information on the issue and provided a problem statement. Next, the research purpose and questions were stated. The theoretical construct of public pedagogy, and 11 key terms for context, were described next, followed by an

overview of the netnographic case study methodology. Lastly, the chapter described my professional experience and connection to the topic. In the next chapter, I explore the evolution of the Internet as a tool for informal, self-directed learning. Chapter 3 describes the study's qualitative collective case study methodology. The results are shared in Chapter 4 through narrative, qualitative examples and quantitatively identified patterns. Chapter 5 shares a reflective conclusion of the current state of the discipline, study limitations, and future research directions.

CHAPTER TWO

Computers can be carriers of powerful ideas and the seeds of cultural change.

Seymour Papert (as cited in Ito & Howe, 2016, p. 103)

Literature Review

The following literature review explores the evolution of the Internet as a tool for informal, self-directed learning and lay the groundwork for my case study. My overarching research question for the case study was: How do scientific outreach organizations think about and implement a version of public pedagogy online? To get to this answer, I planned to investigate the following research subquestions:

1. How are public websites designed to serve as learning spaces for informal, self-directed adult learning?
2. What metrics are used to evaluate learning and behavior-change associated with public websites?

To support this inquiry, this chapter introduces a foundational understanding of informal adult learning related to technology, the role of expertise, and evaluation. This includes a contextual analysis of the varied terminology used to define this space, including behavior change, constructivism, design, disciplinary matrix, effective, engagement, heugagogy, informal learning, and pedagogy. To begin with, this review discusses how technology in informal learning, over time, has resulted in greater and greater access to information. As information and constructivist discourse is more accessible through the modern Internet era, the evolving role of expertise is discussed next. Lastly, the challenge of evaluating informal online learning, and the varied approaches taken by those seeking this kind of evaluation, are shared. Overall, this chapter provides a conceptual framework that informs the case study analysis. This chapter concludes by synthesizing the

significance of this topic with a discussion of what is known about how adults learn informally online today and recent research trends.

Technology in Informal Learning

Informal learning is a practice as old and varied as life itself. In the scheme of things, technology's role in informal learning was not far behind the advent of informal learning. Harasim (2017) described four paradigms that represent the major advances in teaching and learning with technology: (a) speech, beginning around 40,000 before common era (BCE); (b) writing, circa 3,500 BCE; (c) printing and mass communication, including Gutenberg's printing press in 1455 common era (CE), the Pony Express in 1860 CE, the telegraph in the 1830s, and the telephone in 1876 CE; and finally, (d) the Internet, which began in 1969 as computer networks and evolved to the public world wide web by 1993 CE. In the early days of the Internet, now identified as Web 1.0, we began seeing a compilation of resources for passive reading. Then came Web 2.0 with two-way modes of communication or interaction on the Internet. Where Web 1.0 was a repository of information, Web 2.0 is designed for multidirectional communication and collaboration (Rollett et al., 2007). It is characterized by the emergence of user-generated content and social media platforms, such as blogs, social networking, bookmarking sites, collaboratively edited websites (e.g., wikis), and more. Present vast utilization of search engines (i.e., Google) for utilitarian purposes has allowed them to quickly build a lot of trust. However, Nobel warned the popular "notion that search engines are somehow online public libraries, that they are trusted, curated public portals that lead us to the most credible information" (as cited in Howard, 2018, para. 11) is false. While informal learners reap the benefits of the breadth of information available online, they also must be mindful of the limitations of this technology.

Online courses. Initially, online courses were developed to provide greater access to nontraditional students pursuing traditional degrees. Low completion rates and the stark differences in quality from course to course have long been seen across the field of online education. Bailey and Card (2009) found that while "institutions have focused on providing faculty with technological training to enhance their online teaching . . . many online instructors would like to learn more effective pedagogical practices" (p. 152). After interviewing experienced award-winning e-learning instructors for a phenomenological study, Bailey and Card (2009) found eight effective pedagogical practices for online teaching, which happened to be quite similar to in-person teaching: (a) fostering relationships, (b) engagement, (c) timeliness, (d) communication, (e) organization, (f) technology, (g) flexibility, and (h) high expectations. Bailey and Card related these findings to the principles of andragogy, constructivism, and transformative learning.

Taking this concern further, Quality Matters (2017) is an organization that began organically as a group of colleagues who wanted to answer the question, "How do we measure and guarantee the quality of a course [online]?" (para. 1). They created a series of rubrics and trainings and certify the quality of blended and fully online courses. The rubrics are widely respected across the field of education. More than 1,300 colleges and universities have participated in the program, over 52,000 professionals have been trained on the standards, and thousands of online courses have been certified (Quality Matters, 2017). The Open SUNY Course Quality Review (OSCQR) process, International Association for K-12 Online Learning (iNACOL) National Standards for Quality Online Courses, and Bb Exemplary Course Program are a few other assessment and planning tools similar to Quality Matters. Still, there is a great deal of agreement that online-

learner engagement and course completion rates are often low, especially in the noncredit setting (Clow, 2013; Rovai, 2003; Tyler-Smith, 2006; Walji, Deacon, Small, & Czerniewicz, 2016).

MOOCs are open, structured, online learning environments that threatened to disrupt traditional higher education when they came on the scene in 2008, growing in popularity by 2012. However, they have faced many of the same engagement challenges as traditional online courses, often with fewer resources to work toward solving them. Clow (2013), aiming to address the learning analytics of the MOOC movement, described a *funnel of participation*. The participation funnel begins with awareness and moves to registration, through to activity, and finally to progress; there is a steep drop-off at each stage (Clow, 2013). While Quality Matters (2017) may have supported increased engagement, the voluntary nature of many MOOCs likely limits the improvements that can be made to completion rates.

Walji et al. (2016) found MOOC participants surveyed about activity and resource type preferences had the greatest spread of opinions on discussion forums, from *strongly like* to *strongly dislike.* However, even those who did not personally contribute to the discussion have benefited from the experiences and resources others shared. In fact, "other learners voiced their appreciation: 'I've really enjoyed hearing about such a variety of topics but have actually found the comments made by other participants to be just as, if not more at time, interesting'" (Walji et al., 2016, p. 9). In another study, Starasts (2015) found "information seeking was highly experiential—having an experience, and then reflecting on and sharing this, were major planned and deliberate information-seeking activities" (p. 159). Others benefited as the learner shared his experience on a community listserv. Numerous studies highlighted the value of learners

communicating with one another to share and develop knowledge (Clark, 2005; Cook & Smith, 2004; Harju, Pehkonen, & Niemi, 2016; Kop, 2011; Liu, McKelroy, Kang, Harron, & Liu, 2016; Quintana & Morales, 2015; Starasts, 2015; Ziegler, Paulus, & Woodside, 2014). Constructivist theory values the messiness of exploration, community discourse, and the personal reflection that is also so critical to heutagogy.

Out-of-class online learning. Further outside the validity of the Quality Matters (2017) framework lies the truly informal learning a majority of people embark on daily. Blaschke (2012) explained:

> Web 2.0 and social media has played an important role in generating new discussions about heutagogy [given that] Web 2.0 design supports a heutagogical approach by allowing learners to direct and determine their learning path and by enabling them to take an active rather than passive role in their individual learning experiences. (para. 17)

An obvious example of heutagogy is Wikipedia. Created in 2001, Wikipedia quickly became one of the world's most visited websites (Hendricks & Hansen, 2016). Despite the constant threat of vandalism, sabotage, and other challenges surrounding having around 75,000 active volunteer contributors, its accuracy rivals that of the historically trusted *Encyclopedia Britannica* (Hendricks & Hansen, 2016). Furthermore, it lives up to the ideals of critical theory and the belief of Brookfield (2005) and Foucault (as cited in Brookfield, 2005) that power is not given nor received but instead is exercised and "only exists in action" (p. 124). Wikipedia is a platform that supports transparent and collaborative truth seeking and knowledge construction in a community of self-directed volunteers learning together in a public space online, like the discussion forums employed by education's constructivists. This is critically important because people

naturally feel threatened when faced with overwhelming evidence contrary to their strongly held beliefs (Gal & Rucker, 2010). When receiving new information, it interacts with implicit biases and theories in use (Greenwald, McGhee, & Schwartz, 1998; Senge, 2006). Through reflective practices, we can work to bring these to the conscious mind so deeper learning and cognitive changes can occur.

Role of expertise. Unfortunately, today's media landscape, seeded with intentionally false articles, threatens to create challenges in the fact-checking process and undermine our ability to be accurately informed (Jang & Kim, 2018). Therefore, while some informal online learning communities function on peer discourse alone, other informal learning communities "provide members with access to some form of expertise through, for example, domain experts, databases or links to repositories of learning objects" (Chunngam, Chanchalor, & Murphy, 2014, p. 864). Learning objects are defined as flexible content segments or educational activities, generally small in scope, that are reusable, scalable, and adaptable to differing needs and motivations (Ally, Cleveland-Innes, Boskic, & Larwill, 2006). While peer-created understanding is essential, Chunngam et al. (2014) found that by providing credible information, membership of the site they studied was strengthened and learning was facilitated.

Role of experts. The role of experts in the context of informal online learning is to function as facilitators of learning rather than gatekeepers to information (Tweddle, James, & Daniels, 2000). When this is accomplished, a study of informal online social networks found "the themes that are addressed [by the group] are more varied and are dealt with [through discussion] in more depth in moderated communities" (Lisbôa & Coutinho, 2011, p. 172) than in unmoderated communities. However, self-moderation in informal learning has also proven valuable (Quintana & Morales, 2015). In any case,

experts should not be made the central focus (Chunngam et al., 2014; Lisbôa & Coutinho, 2011). Furthermore, another study found that "users expect recommendations based on their personal needs (such as taking into account the proficiency level when suggesting activities)" (Louys, Hernández-Leo, Schoonenboom, Lemmers, & Pérez-Sanagustín, 2009, p. 77) and desire feedback. Learners, even informal ones, do not want to feel lost.

Usability and searchability. Articles also spoke to the critical nature of a learners' ability to easily search and navigate resources to truly have the choice and control they want (Ally et al., 2006; Bear, 2012). Informal learners come to the experience with a "strong sense of their specific and individual situation that defined their information needs and guided their information seeking" (Starasts 2015, p. 159) and therefore need to be able to easily find what they are looking for. This ease of use also supported the sense of enjoyment that leads to learning (Lin & Gregor, 2006). In a study looking at how learners choose learning objects, such as websites, documents, and audio clips, Ally et al. (2006) found learners primarily choose learning objects that they expect to increase their knowledge and skills in the topic described in the learning object's title and description. Specifically, they indicated that "the title must reflect the content of the learning object and must be inviting" (Ally et al., 2006, p. 55). An indication of level and scaffolding for specific learning objects is also helpful (Lisbôa & Coutinho, 2011; Liu et al., 2016; Tweddle et al., 2000). In self-directed, informal learning, prioritizing web accessibility and search engine optimization (SEO) strategies, such as effective titling, keyword tagging, and logical site architecture, is critical to attracting and retaining potential learners.

Evaluation and Informal Learning

When learning informally, individuals determine when, where, and what they want to learn without externally imposed objectives nor curriculum, making effectiveness particularly challenging to measure (Livingstone, 2007; Tweddle et al., 2000). Skyrme (2001) suggested that, while it is not the ultimate measure of success, "the number of unique visitors is an important interim metric" (p. 65). Another low-investment approach is content appraisal, a strategy from the information marketing field (Nadeau, Heidorn, Broady, & Whittle, 2012). In health-related contexts, the *dosage* is a critical variable used to validate the depth of one's experience. Dosage, in this case, is defined as the time engaged in the learning experience. It is a tangible measure, and evidence of a relationship between time spent and outcomes (i.e., dose-response relationship) has been found in the use of online interventions (Christensen, Griffiths, & Farrer, 2009; Donkin et al., 2011; Wangberg, Bergmo, & Johnsen, 2008). However, as Livingstone (2007) asserted, "The amount of time that people spend in *learning processes* is not necessarily positively correlated with successful *learning outcomes*" (p. 218). While there are evaluation options related to the site content and related data, they are not outcome measures.

Hoffmann and Koch (1998) asserted, "Learning in general can be defined as a behavioral change resulting from individual information processing" (p. 161). This idea is echoed by Mellander, Chief Designer for a Swedish marketing company and developer of learning techniques, who said, "The value of what you know can only be seen in what you do" (as cited in Skyrme, 2001, p. 1). The RE-AIM framework, named for its strategy of measuring a resource or intervention's reach, effectiveness, adoption, implementation, and maintenance, can be employed to understand the influence of a resource or

intervention, and is particularly helpful in the developmental evaluation phase (Cronin, Hendrickson, & Croymans, 2018). Similarly, Guion and Free (2010) suggested a conceptual framework for infusing behavior change theories into program design, delivery, and evaluation using a combination of the trans-theoretical model of behavior change, diffusion of innovations theory, and an ecological approach (see Table 1). This practical illustration of the application of well-established theories in modern online spaces is of critical importance to moving this work forward.

Tobey, Koenig, Brown, and Manore (2016) took an approach similar to Guion and Free's (2010) framework (see Table 1). Tobey et al. (2016) measured the outcomes of an educational social marketing campaign by conducting interviews, recording on a 5-point scale how strongly participants agreed with belief statements before and after the launch of the campaign. This was a valuable strategy given the literature suggests the ability to measure change in one's belief more clearly measures actual learning outcomes and community impacts than experimental models or standardized tests commonly used to measure learning (Ellsworth, 2005; Park, 1994). Test scores and associated knowledge gains can, however, be used to explore informal learning outcomes when placed in appropriate relation to the factors at play. Joksimović et al. (2018) suggested a model with a bilateral connection between the learner's context and their indicators of engagement, and ultimately their immediate, course level, and post-course outcomes (see Figure 2). The outcomes at each stage include academic- or skill-based, social, and personal-affective measures. Context, in the model, includes demographics, the classroom setting, and individual needs (Joksimović et al., 2018). As with this model of semiformal MOOC learning environments, and perhaps even more so, there are many variables at play in informal learning, and quality impact evaluation must reflect this.

Table 1

Guion and Free's Framework for Designing, Delivering, and Evaluating Behavior Change Focused Educational Strategies

Stages of Change	Moving Clientele from one Stage of Change to Next	How Change is Adopted	Educational Strategies	Evaluation Strategies
Pre-Contemplation	Consciousness-raising, dramatic relief, environmental reevaluation	Create awareness and interest; emphasize relative advantage; create awareness of how significant others might be affected	Exhibits/displays, radio, television, and/or newspaper ads; fact sheets; newsletters; web sites; blogs; podcasts; email alerts/blasts	Measure increased awareness, interest in changing, amount and type of info distributed, & number reached
Contemplation	Self-re-evaluation	Increase knowledge; reduce complexity; address compatibility; change attitudes	Financial management classes, workshops, and seminars that include examples, testimonials, program results, and alternatives	Measure perceived or actual knowledge gain, attitude and/or confidence change
Preparation	Self-liberation, social liberation	Develop or increase skills; offer opportunities for trialability	Financial management skills training that includes incentives, mentors and demonstrations	Measure skills & future intentions to change behavior
Action	Reinforcement, helping relationship, counterconditioning	Provide support and incentives; offer opportunities for observability	Develop goals and plans, provide tools, incentives, support	Measure increased support and perceived or actual changes
Maintenance	Stimulus control	Provide follow-up and support	Accountability check up & support	Measure long-term impacts

User-based relevance in informal learning is complex, especially when aligned with learner context and engagement. Given this, experimental design seems too limited and naturalistic inquiry, then, is an essential element of informal learning research (Park, 1994). Park (1994) stated, "We need to make a paradigm shift away from the traditional

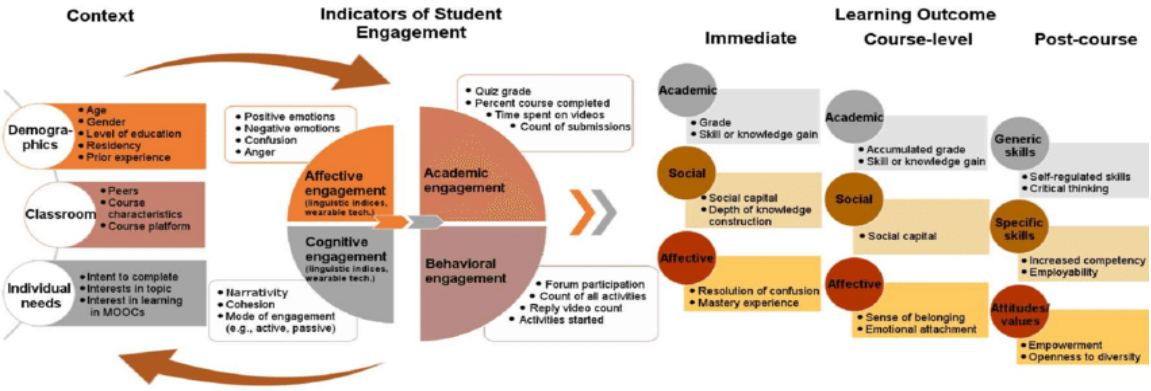

Figure 2. A model for contextual analysis of MOOCs. Adapted from "How Do We Model Learning at Scale? A Systemic Review of Research on MOOCS" by S. Joksimović et al., 2018, *Review of Educational Research, 88*, p. 59.

experimental research in studying information need and uses" (p. 139) in summarizing the positions of Mellon, Dervin, and Nilan. Furthermore, Mellon et al. asserted a need to instead develop "a clearer understanding of fundamental concepts such as 'information,' and 'information need' in the context of the user" (as cited by Park, 1994, p. 137). Yet, naturalistic inquiry is tricky. Seger (1994) described implicit learning as nonepisodic and occurring incidentally without awareness. Also acknowledging this reality, Livingstone (2007) asserted that interviewees are unreliable when "asked to identify and estimate informal learning activities without reference to the other activities and time commitments that they are involved in" (p. 219). It is critical to keep in mind the cognitive challenges at play when designing the overall methodology of a naturalistic study.

Decisions about methodological rigor are made based on how three costs—money, time, and participant burden—weigh against the benefits of the highest levels of rigor (Braverman & Arnold, 2008). At the same time, external factors, such as funder requirements, opportunity, standards and trends in the field, requirements for formal program recognition and legitimation, evaluator expertise, and organization culture, also

play into decisions around methodological rigor (Braverman & Arnold, 2008). Evaluation in publicly funded informal education contexts is primarily done for program improvement and, secondarily, for accountability (Braverman & Arnold, 2008). This educational evaluation includes outcome and impact studies, with expectations generally defined by organizational leadership. Measurement design and other elements related to rigor, however, are often left to the discretion of the evaluators (Braverman & Arnold, 2008).

The Network of Networks on Impact Evaluation (NONIE), an international organization committed to improving impact evaluation stated, "Methods, techniques and approaches for impact evaluation should match the specific circumstances of the evaluation—its purpose, the nature of the intervention, the questions, the level of existing knowledge, and the resources available" (as quoted by Patton, 2008, p. 114). NONIE continued, "*Methodological appropriateness should be considered the 'gold standard' for impact evaluation* [emphasis in original]" (as cited in Patton, 2008, p. 114). Patton (2008) wanted to see evaluators working in informal educational contexts to stop apologizing for not using randomized control trials and instead confidently explain the appropriateness of the selected methods given the purpose, resources, and timeline.

Summary

Researchers have a very limited understanding of what, how, and how well adults learn informally, with the bulk of related case study work occurring in the 1970s (Livingstone, 2007). Those case studies informed 11 larger scale surveys over the next 25 years meant to confirm and further investigate the case study findings (Livingstone, 2007). Today is a very different time. With Web 2.0 in most of our pockets, "information is readily and easily accessible [and] change is so rapid that traditional methods of

training and education are totally inadequate" (Hase & Kenyon, 2000, para. 3). Therefore, this study used an emerging public pedagogy for the web as a framing theoretical concept. The resulting organization-level case studies aim to pick up where existing literature has left off, documenting the design of informal learning opportunities online in a more holistic way than the existing studies that primarily investigate discrete platforms, such as blogs, MOOCs, or listservs. Using their website as the base to look inclusively at the organization's online presence, the theoretical perspective, evaluation strategies, and research foci of each case are identified. As this review of literature has demonstrated, these may vary significantly. In any case, by more deeply understanding how informal online learning is designed for and measured, organizations that seek to share credible research with the public can strengthen their online practices. The next chapter provides a detailed description of the study's methodology.

CHAPTER THREE

A model is not something to be replicated but rather it is a demonstration of the feasibility of a principle.

John Dewey (as cited in Patton, 2011, p. 167)

Methodology

Why are MOOCs failing and fading away while Wikipedia is thriving and increasing in its credibility? (Friedman, 2014; Harasim, 2017; Hendricks & Hansen, 2016). It will be important for other organizations, especially public institutions aiming to educate those outside of school, to understand what is and is not working in supposed and actual revolutions in information and learning-focused websites to most effectively use resources and increase the knowledge of the citizenry. Therefore, my overarching research question for this study was: How do scientific outreach organizations think about and implement a version of public pedagogy online? To get to this answer, I investigated the following research subquestions:

1. How are public websites designed to serve as learning spaces for informal, self-directed adult learning?
2. What metrics are used to evaluate learning and behavior-change associated with public websites?

I believe that if legacy institutions like colleges of extension do not grow and evolve with changing information-seeking and informal learning practices, they will die. A primary challenge of making substantial change is the challenge of conceptualizing a wholly different approach. This includes not knowing how to plan a multilayered program that educates flexibly on public websites and not knowing how to feasibly and credibly measure learning and behavior change in these flexible, open educational programs.

Rationale for Research Approach

Some organizations are beginning to use digital content and web strategy to support informal learning. Studying these organizations with a qualitative case study methodology facilitated an exploration of this phenomenon through multiple data sources and lenses (Baxter & Jack, 2008). Through this, a theory of public pedagogy for the web could be developed and utilized for the greater good. Yet, a pedagogy for the web cannot be distilled to a clear formula or recipe, but rather a set of effective principles. In *Developmental Evaluation*, Patton (2011) described best practices as a simple recipe and programs that deal with complexity as being better correlated to parenting. Patton (2011) explained, "Parenting is highly variable and situational. There can be no recipe or set of specific rules. But there can be and are effective principles, like 'nurture each child's uniqueness'" (p. 167). Patton (2011) also highlighted the importance of the word *effective* rather than *best* as a descriptor of the principles that emerge from case studies, as there "is no way of establishing 'best'" (p. 167). Cronbach and the Stanford Evaluation Consortium suggested case study research should design studies with a balanced approach to "depth and breadth, realism and control, so as to permit reasonable 'extrapolation'" (as quoted by Patton, 2011, p. 165). Given the objective to illustrate a public pedagogy for the web for a wide variety of possible applications, a collective case study was more impactful than a singular case study.

Research Setting and Ethical Considerations

Due to the nature of this research taking part primarily in the online environment, I drew on the practices of netnography for data collection (Kozinets, 2015; Zeller, 2017). As defined by Kozinets (2015), netnography is specific to

> research practices, where a significant amount of the data collected and participant-observational research conducted originates in and manifests throughout the data shared freely on the Internet, including mobile applications. (p. 79)

In accordance with netnography practices, "online social interactions [are] considered to be research with human beings" (Kozinets, 2015, p. 224), while analysis of web structure and content is nonreactive and more akin to document analysis.

Data available in public, nonsubscriber, or member areas are considered open for "manual, non-automated access" (Kozinets, 2015, p. 154) for this academic research purpose under the U.S. fair-use laws. When determining whether to cite, anonymize, or credit research participants in the case studies, I have referred to Kozinets' (2015) three levels of concealment and fabrication based on perceived risks and the public nature of the individual and the data loss risk of anonymity. Ultimately confirming decisions with my committee, I also recognized that multiple judgments could be legitimately made (Sloan & Quan-Haase, 2017). I did not gathering any information in semiprivate areas of the Internet that require fee-based membership and registry, such as chat rooms, listservs, and nonpublic social networking pages. Before requesting interviews with practitioners at the studied organizations, I first created a research webpage to introduce myself and my research (see Appendix A), focusing on the *informed* element of informed consent (Kozinets, 2015; Salmons, 2017). When granted interviews, I shared a letter for informed consent and obtained written consent from participants (see Appendixes B and C). Furthermore, interview participants were adults who are not, to my knowledge, otherwise considered a vulnerable population. Overall, I have been guided by a *do no harm* approach and face very low risk given my chosen research topic. The type of data being

collected and stored include descriptions of site and research design, and learning and behavior change measurement strategies, not personal or otherwise sensitive information (Beninger, 2017). The Institutional Review Board (IRB) found these methods to be exempt from review and therefore approved (see Appendix D).

Case Study Questions

My overarching research question was: How do scientific outreach organizations think about and implement a version of public pedagogy online? To get to this answer, I investigated the following research subquestions:

1. How are public websites designed to serve as learning spaces for informal, self-directed adult learning?
2. What metrics are used to evaluate learning and behavior-change associated with public websites?

Case Definition and Selection

McMillan and Schumacher (2010) defined a case study as examining "a *bounded system* [emphasis added], or a case, over time in depth, employing multiple sources of data found in the setting" (p. 24). The collective case study has been selected for this research due to its ability to "uncover new and/or divergent themes" (Zach, 2006, p. 19). Such a collective case study aims to reach saturation through its sample, which is never a guarantee in any sample size (Zach, 2006). Three cases was the initial number selected for its ability to include diverse perspectives while remaining a small enough sample to afford time for deep investigation. For limitation reasons outlined in Chapter 5, the collective case study was ultimately inclusive of two organizations.

The case or cases can be selected for uniqueness or ability to illustrate a specific issue (McMillan & Schumacher, 2010). This study selected three cases for their abilities

to illustrate learning environment variables Anderson (2008) placed at the outer corners of his model (see Figure 1); these are independent study, structured learning resources, community of inquiry, and paced, collaborative learning (Anderson, 2008). I also looked for cases that teach scientific information in English for a primarily adult, nonvulnerable population, and for cases with missions including the public good. Lastly, cases were prioritized for likely access to needed information and the overall representation of a range of topics and organizations. As a component of access to information, the extent to which the case is publicly funded was considered. See Table 2 for more inclusion and exclusion criteria details.

After using the case study selection criteria (see Table 2) to review 40 websites from a variety of museums, website design award-winning nonprofits, and U.S. federal agencies who share scientific information with the public (see Appendix E; Top Nonprofits, 2017; Web Awards 2018, n.d.), I determined the five potential cases for the study, listed in order of preference: foodsafety.gov, NOAA.gov, fieldmuseum.org, aqua.org, and worldwildlife.org. In recognizing my ability to secure interviews as critical to the study, this strategy of identifying five potential cases for the study was designed for flexibility.

While I originally proposed studying three organizations, I was unable to secure interviews with foodsafety.gov, aqua.org, or worldwildlife.org. Given the essential nature of interviews to this study, NOAA.gov and fieldmusuem.org were ultimately the two cases included in this study. NOAA.gov is the website of the National Oceanic and Atmospheric Administration (NOAA), a government agency with an annual budget of approximately $6 billion with a scientific and outreach mission that include topics of climate, weather, oceans, and coasts (Cahlink, Koss, & Lunney, 2018). The Field

Table 2

Determining Case Study Selection

Inclusion Criteria	Exclusion Criteria
Demonstrates learning environment variables (Anderson, 2008)	Does not demonstrates learning environment variables (Anderson, 2008)
Teaches evidence-based information	Educational content is not backed by evidence
Cases together represent a range of evidence-based topics and types of organizations	Cases together are all very similar in topic and type of organization
Access to information needed to answer case study questions is likely	Access to information needed to answer case study questions is unlikely
Audience is primarily adult learners in a nonvulnerable population	Audience is not primarily adult learners or is primarily serving a vulnerable adult population
Mission includes public good component	Mission is only for the individual's benefit
Includes public funding	Entirely privately funded
Online content is available in English	Online content is not available in English

Museum is a Chicago museum open since 1894. It has an annual budget of more than $60 million (GuideStar, 2018; S. Wigodner, personal communication, July 27, 2018). The museum is a nonprofit that conducts research, promotes conservation, and educates with a mission to ensure a thriving planet well into the future. This combination of cases provided insight into two distinct types and sizes of organizations, each with a wide range of scientific outreach topics but serving a similar function.

Data Collection

Given the focus of my research questions on website and content design and evaluation strategies, I collected data through observation, document analysis, and interviews. The first method of data collection was conducted as a participant observer,

authentically consuming and interacting with the information and participants for approximately one hour per week per site (Kozinets, 2015; Stewart, 2017). I observed elements related to the design and evaluation, not reflecting on my experience as a learner, as one would in autoethnography. At the same time, to clarify what is observed and to shed light on what cannot be observed, I searched for relevant reports and articles and scheduled and completed interviews with staff involved with the launch, execution, or management of the public educational resources on each site.

My first supporting research question was: How are public websites designed to serve as learning spaces for informal, self-directed adult learning? This question was primarily identified through observation while interviews closed some gaps in understanding. The second supporting question was: What metrics are used to evaluate learning and behavior-change associated with public websites? This question relied initially on observation but also included interviews and document analysis of public reports and articles. A primary objective of observational data collection is to capture the contexts accurately for narrative representation. Interviews and document analysis further identified *the how* and shined a light on *the why* behind the development and evaluation of informal learning spaces. Overall, my focus was on manually gathering data that were site design and content-based, not related to individuals (Mayrs & Weller, 2017). A semi-structured approach was used for observations and interviews (Salmons, 2017; see Appendix F). All data were collected in a spreadsheet workbook that functioned as my field notes and aided in analysis (Stewart, 2017; see Appendix G). The interview guide and field notes spreadsheet workbook were piloted and revised.

Data Analysis

Theoretical saturation can be achieved through a quantitative ethnographic (QE) analysis (Shaffer, 2017). Shaffer (2017) developed the QE approach to thicken data with the cultural context needed to make meaning. Quantitative ethnographic calls for qualitative examples, graphical representation, and statistical tests. The case studies' learning design and evaluation approaches are described through narrative, qualitative examples and patterns identified have been highlighted in summaries as *lessons learned,* which may be useful to readers if applied to similar situations (McMillan & Schumacher, 2010). An epistemic network analysis (ENA) was performed to provide a graphical representation of the relationships present across the theoretical perspective, methodological practices, and research foci as documented through the field notes and interview transcripts, using codes pulled from the literature discussed in Chapter 2 (Ellenbogen et al., 2004; Shaffer, 2017). The first set of codes used in my field notes traced the interaction variables to unearth the theoretical perspective about what counted as learning activities: (a) independent study; (b) structured learning resources; (c) community of inquiry; and (d) paced, collaborative learning (Anderson, 2008; see Appendix G). The second set of codes used the research methodologies present in the studies reviewed in Chapter 2: (a) surveys/questionnaires, (b) textual analysis, (c) interviews, (d) observation, (e) log files/learning analytics, (f) social network analysis, (g) focus groups, (h) case study development, and (i) pre and posttests. The last set of codes identified the research foci used in organizational evaluation: (a) unique visitor count, (b) content appraisal, (c) stages of behavior change, (d) RE-AIM, (e) time spent, (f) learning outcomes, and (g) enjoyment (see Appendix G). The ENA illustrated how and how closely these elements were connected to one another, and thus uncovered the way the

organizations, and more specifically the group of practitioners interviewed, thought about the practice of informal online learning (Shaffer, 2017). Congruence, or lack thereof, illuminated through the ENA informed the discussion of how close the field is to an emerging disciplinary matrix (Ellenbogen et al., 2004; Kuhn, 2015).

Validity and Reliability

Context and reasoned application is critical to the use of public pedagogy for the web. For this reason, Patton explained, best-selling management books do not offer best practices. They share effective principles. “Not incidentally,” Patton (2011) continued, “these works are based on qualitative case studies . . . not randomized control experiments” (p. 167). Scriven, another evaluation pioneer, is quoted by Patton (2011) as having explained, “Size is one way to statistical significance, but it often gets in the way of good evaluation and good development” (p. 166).

When it comes time to reauthorize and fund programs, outcome measures are critical to the political discussion (Lagemann, 2000). This, in and of itself, is useful, but on tight timelines and short budgets, there is a strong numbers-based bias in how we measure success. Additionally, professionals in the scientific outreach education space desire to be “just as scientific as their university peers” (Lagemann, 2000, p. 21) and, along those lines, a desire to gain status as professionals, was the most influential reason early educationists moved toward quantitative research, and likely why we continue in that vein today. After all, the nature of the university promotion process requires faculty peers to find their work adequately scholarly and credible. Yet, to develop an understanding of the *how* of a contemporary platform over which the researcher has no control, quantitative research cannot hold a candle to the value of case studies (Yin, 2018).

This case study was designed with awareness of the weaknesses, real and perceived, of case study methodology and therefore used two tests for validation. First, construct validity was identified through multiple sources of evidence, including netnographic study of online content and guided interviews. When possible, construct validity was supported by having "key informants review draft[s of the] case study report" (Yin, 2018, p. 43). Patton (2011) described a case study's need to rely on "both data and *reasoning* [emphasis added]" (p. 164), which is necessarily subjective. However, evaluation pioneer, Stake, used an approach described by Patton (2011) as "co-creation between the social innovator and the developmental evaluator" (p. 164). While this still is susceptible to bias that cannot be completely mitigated, the socially constructed knowledge Stake described takes a step toward triangulation for validity. Second, reliability was supported through the use of this case study protocol that included housing data in a spreadsheet workbook that maintained a clear chain of evidence and a clear code book with definitions and examples. The codes in the spreadsheet allowed the pairing of qualitative analysis with quantitatively generated graphical representations through an ENA for theoretical saturation (Shaffer, 2017; Yin, 2018). When used together, construct validity and reliability supported the credibility of this collective case study.

Delimitations

This study benefited from certain delimitations established to provide a useful scope for meaningful analysis. First, I chose to look only at websites used for nonacademic, noncredit, self-directed learning for primarily adult learners. While research about informal online spaces focuses primarily on relationships, this study focused primarily on the design of the teaching and learning, including the website's

structure, content, and functionality. While this may include an incidental look at relationships, the study used a design lens rather than a sociological lens. This is an emerging field of research, both in terms of topic and method, so effective practices are limited. Kozinets' (2015) *Netnography: Redefined*, Shaffer's (2017) *Quantitative Ethnography*, and Yin's (2018) *Case Study Research and Applications: Design and Methods* were my primary guides.

Summary

This chapter included a description of and rationale for a collective case study research approach. It shared details about the study's research setting and ethical considerations, case study questions, case definition and selection, data collection and analysis, validity and reliability, and delimitations. To support a "better understanding of practice or issue and [facilitate] informed decision making" (McMillan & Schumacher, 2010, p. 338), the next chapter shares the results and analysis of the collective case study.

CHAPTER FOUR

In the technology world, the equivalent of a thriving bazaar is a successful platform.

Tim O'Reilly (2011, p. 15)

Results

This chapter presents the findings of each case study with a QE approach, including qualitative examples and graphical representations. Statistical tests, the third element of QE, are discussed in Chapter 5 when the cases are compared and discussed collectively. The results presented here serve as the foundation to answer my overarching research question: How do scientific outreach organizations think about and implement a version of public pedagogy online? The results also answer its two supporting questions:

1. How are public websites designed to serve as learning spaces for informal, self-directed adult learning?
2. What metrics are used to evaluate learning and behavior-change associated with public websites?

The results shared focus on the pedagogical design and evaluation decisions discussed in interviews with the organization's staff, observed on their websites and related social media, and found in related articles or news releases.

Findings

This chapter shares the results of individual case studies with a qualitative narrative and graphical representations. The findings are shared with a focus on identifying how the organizations studied, the Field Museum and NOAA, have designed their public websites and related social media strategies to serve as spaces for informal, self-directed adult learning. Metrics that are used to evaluate learning and behavior-change associated with their online outreach education are also explored. These data are

shared individually by organization in this chapter and are revisited in a collective manner in Chapter 5 to support the development of a pedagogical model.

FieldMuseum.org. The Field Museum is a nonprofit museum in Chicago, Illinois, open since 1893, celebrating its 125th anniversary at the time of this study (Field Museum, 2018b). It is a nonprofit with an annual budget of more than $60 million (GuideStar, 2018; S. Wigodner, personal communication, July 27, 2018). At the time of the study, the Field Museum was home to nearly 40 million artifacts and specimens (Field Museum, 2018b). It has not only welcomed the public to learn from its exhibits, the Field Museum has also actively conducted research and has promoted conservation both locally and abroad. In all its activities, the Field Museum "fuels a journey of discovery across time to enable solutions for a brighter future rich in nature and culture" (Field Museum, 2018b, para. 1). This mission is not just written down, it is lived.

The following data on the Field Museum's web and social media design and evaluation were gathered through netnography and interviews. Netnographic participant-observational research was conducted over an approximately two-month period in 2018 on FieldMuseum.org, facebook.com/fieldmuseum, instagram.com/fieldmuseum, twitter.com/SUEtheTrex, twitter.com/FieldMuseum, youtube.com/user/thebrainscoop, youtube.com/user/TheFieldMuseum, and, to a lesser degree, twitter.com/Ehmee. Phone interviews were conducted with the Field Museum's Senior Digital Program Manager, Susan Wigodner, in July of 2018 and Social Media Manager, Katharine Uhrich, in August of 2018 (see Table 3). Public reports and articles found online served as a background resource in preparation for the interviews. Lastly, interview participants were provided with a draft of this data analysis to ensure accuracy of the data's representation.

Table 3

FieldMuseum.org Interviewee Demographics

Name	Position	Education	Years of Experience in the Field	Other Relevant Experience
Susan Wigodner	Senior Digital Program Manager	Master's degree in Museum Studies; Bachelor's Degree in History and Anthropology	6	Museum education roles including teaching and informal learning facilitation, some program planning; developing exhibition media and content; also customer service experience in retail
Katharine Uhrich	Social Media Manager	Bachelor's Degree in English and French	10	8 years at the American Library Association in various positions, concluding as Marketing Director for Booklist Publications; Director of Communications in for-profit industry

Design. FieldMuseum.org's approach to informal online learning is defined internally as *science storytelling.* Wigodner referenced "story" or "storytelling" nine times in the interview; Uhrich referenced this idea four times. Through science storytelling and website functionality, Wigodner described a goal of helping "users explore what they might be interested in," in part by finding themselves in the story. Starting in 2016, a redesign of FieldMuseum.org was in the works, and some baseline research began. Staff were asked how they make use of the current site (see Figure 3) and what they felt the website needed to be communicating as an organization. Wigodner explained the redesign (see Figure 4) included a lot of consideration for how to communicate the "really fun social learning experiences" that take place at the museum.

Prior to the redesign, the museum had over 100 people in different departments around the Field Museum publishing to the website with little formal review process for consistency, so, as a part of the redesign project, a team of three people working in digital

Figure 3. Fieldmuseum.org homepage screenshot from January 17, 2016 (Field Museum, 2016).

content and engagement worked with an outside copywriter to rewrite all of the content for sections of the website. “We're really trying to write in a way that's friendly and inviting, helpfully informative . . . in a way that encourages users to keep exploring around the site,” she continued. Wigodner said:

> In everything that we do at the museum, we're really interested in questions people ask and how we can best communicate that information. When we're creating an exhibition, we often do a lot of upfront evaluation about a topic, so that we can learn what people might want to know about something and answer those questions.

Online, they tell stories related to the exhibitions, but less in depth.

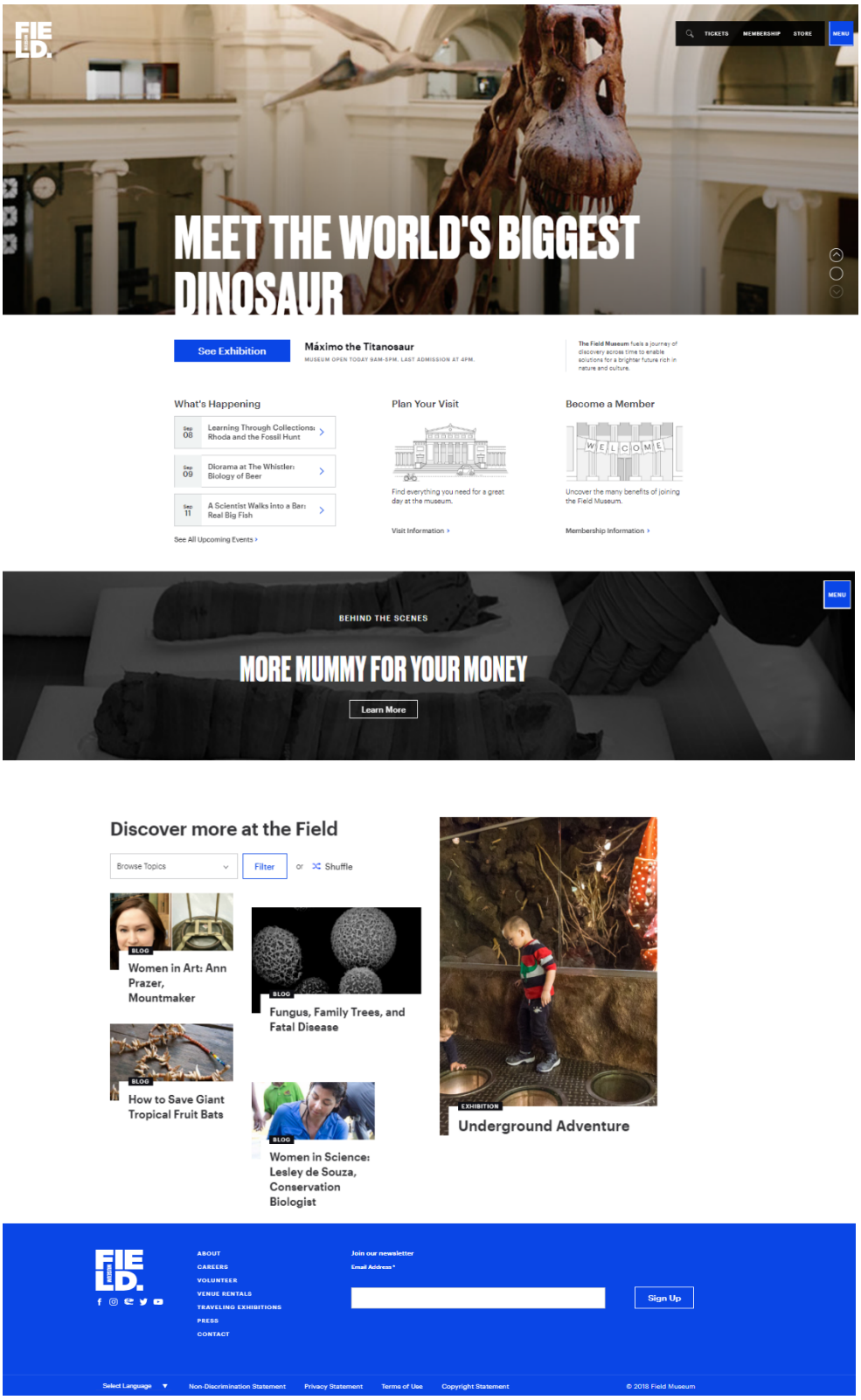

Figure 4. FieldMuseum.org homepage screenshot from September 5, 2018 (Field Museum, 2018a).

The Field Museum wanted to communicate that science happened there daily. In addition to ensuring content was written with the users in mind and that the navigation makes resources findable, the website redesign also had a goal of giving a broader sense of the work and activity that went on at the museum. “We have more than 150 people on our staff who are scientists, are curators, are collection managers, researchers, who really do research and try to learn from our collections every day,” shared Wigodner. They wanted to help the general public discover, explore the world, and learn through their collections. These goals were manifested in the museum with weekly opportunities to Meet A Scientist and a Science Hub staffed by educators using objects to engage visitors, for example. This showed up in other ways online. Wigodner shared:

> We have an educational YouTube channel called *The Brain Scoop* here at the Field, which was started by Emily [Graslie], before she came to the Field. We host that content on our website but we consider that content's primary home to be on YouTube, since that's really where Emily built her audience. So the website is a secondary channel for Brain Scoop. Our team doesn’t produce much video, other than that, unless it's really to support a specific initiative or something else that's going on at the museum. (see Figure 5)

However, the Field Museum’s Digital Learning team, who had previously brought scientists into classrooms for interactive conversations with video calls, had recently refocused their work on creating a new video series now being published to YouTube (see Figure 6).

The Field Museum wanted to create learning experiences that allowed people to share new knowledge with someone else or add to their personal knowledge banks. Facilitating social experiences was also important to them. Not surprisingly, this was

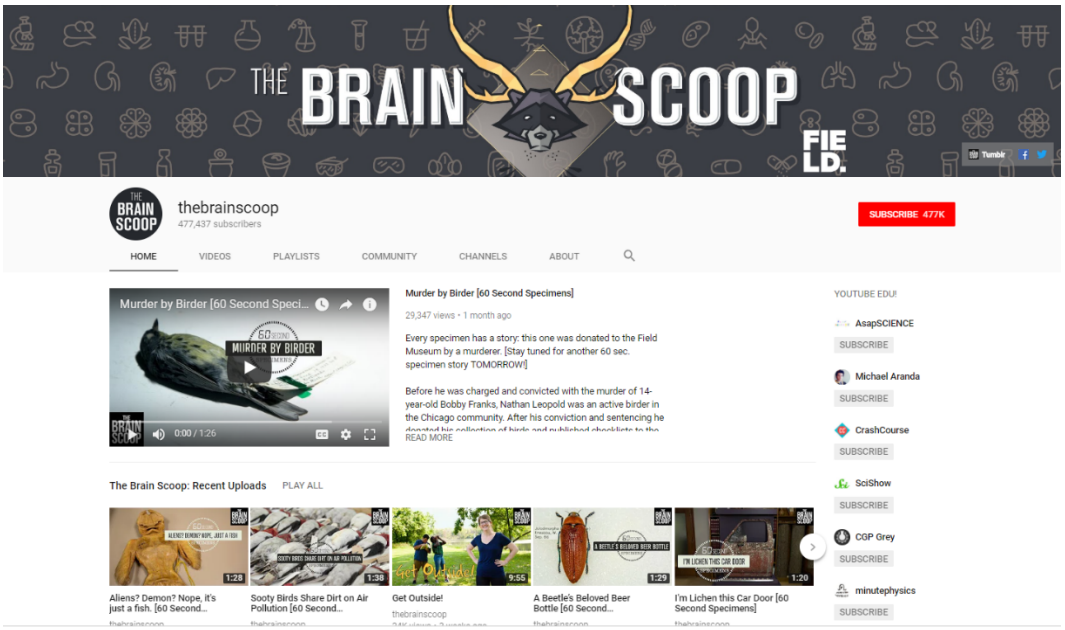

Figure 5. The Brain Scoop's YouTube homepage (Graslie, 2018a).

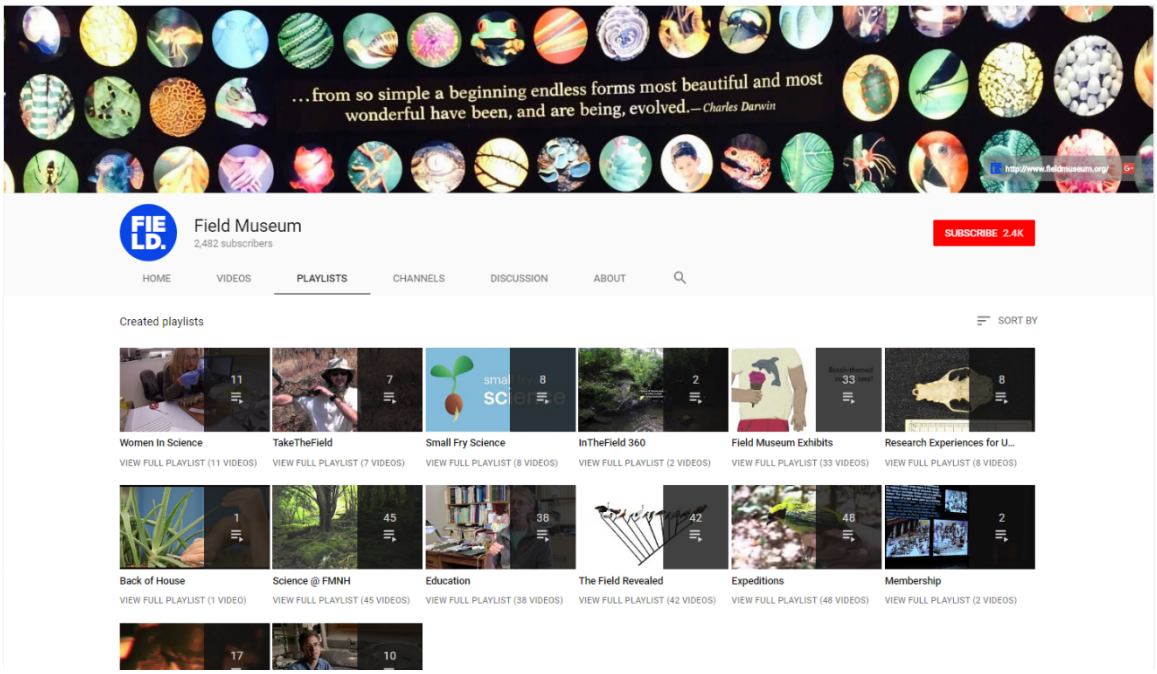

Figure 6. Field Museum's YouTube video playlists (Field Museum, 2018d).

evident on their social media channels, like YouTube, Twitter, Instagram, and Facebook. Website and social media content is a combination of things the museum has been interested in promoting and other stories in which staff understand the museum's audience to be interested. Wigodner shared, "Social [media] is a bit more of a

conversation that we have with people" than the website itself. The people who facilitated the social media accounts for the Field Museum had consulted with subject matter experts around the building, but, in general, Wigodner explained that the museum's internal stakeholders saw social media as more timely and more of a place to take risks in terms of content than they do on the website.

Reviewing the variety of materials and opportunities shared by FieldMuseum.org and related social media, half of Anderson's (2008) interaction variables were used (see Figure 7). Independent study content was used primarily (see Figure 8), followed by community of inquiry opportunities, which occurred on social media platforms (see Figure 9). No paced, collaborative learning or structured learning resource examples were identified on the website or social media currently. As Wigodner mentioned, the digital learning team at the Field Museum had previously offered live interactive video calls with Field Museum scientists but had since moved to an asynchronous model of answering audience questions through an animated video series.

As the Field Museum's Social Media Manager, Uhrich has enjoyed the opportunity to constantly learn while she shares the work of the museum on social media. Taking a *user-first approach*, Uhrich explained that for the Field Museum,

> social media is a lot about storytelling and a lot about inspiring a love of lifelong learning and, obviously, inherent in that is the educational piece. When we're thinking about our content that's obviously at the forefront of our minds, and so while we will certainly mention our newest exhibitions and different events, and potentially talk about items for sale in our store and other marketing driven mentions like that, I think the vast majority of what we're talking about on social media is educational.

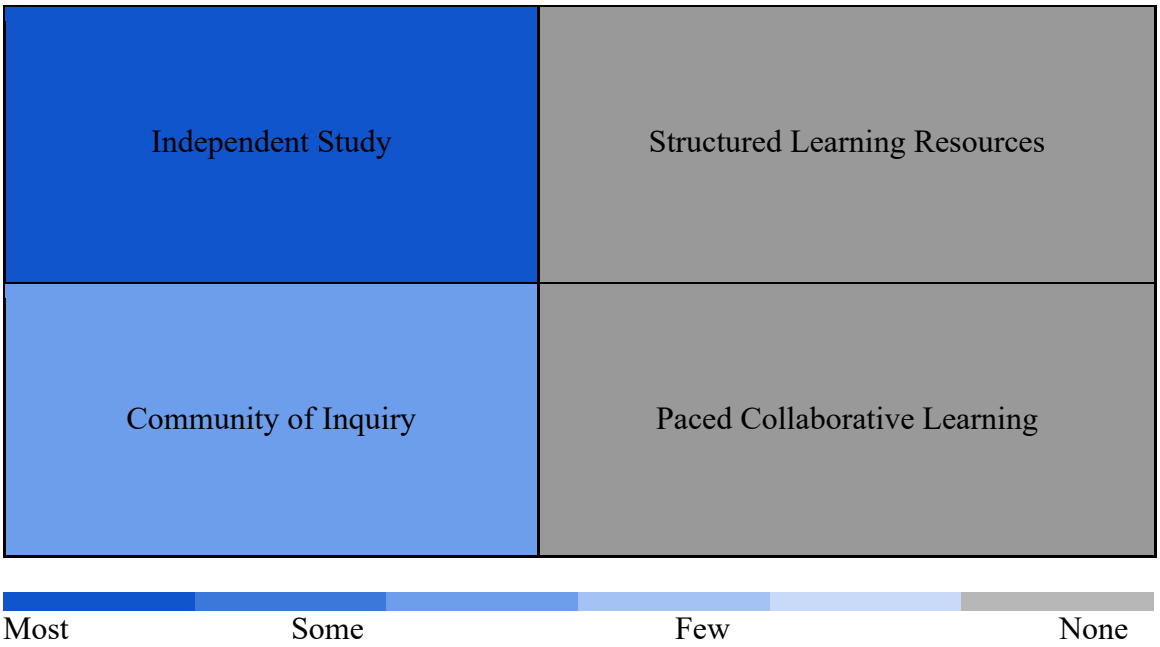

Figure 7. Heat map of Anderson's interaction variables identified on FieldMuseum.org and related social media sites.

Figure 8. Example of independent study resource from the Field Museum's Twitter account (Field Museum, 2018c).

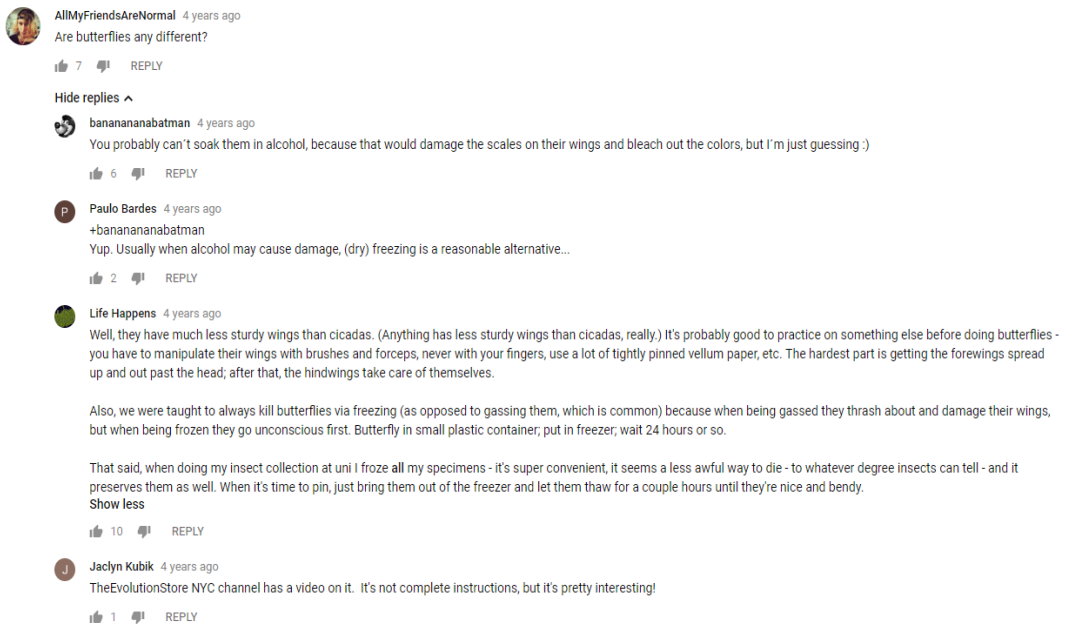

Figure 9. Example of community of inquiry from The Field Museum's Brain Scoop YouTube channel.

The Field Museum's mission, as mentioned earlier, has been "something that everyone who works here really believes in," Uhrich said, "People understand that [social media is] helping us achieve that." Uhrich believed that even though some online visitors do not come to the Field Museum in person and pay full admission to get in and see the exhibitions, it is important to provide opportunities for those visitors to participate in the work happening at the Field Museum from wherever they are. In fact, Uhrich thought, "It's amazing that we can sort of come to them." She enjoyed sharing access to the museum's stories, information, and collections even when distance or finances keep people from visiting in person.

Uhrich shared that the Field Museum wanted to be "viewed as authoritative but not the authority." She explained, "We're about furthering that conversation, and it's not just two people that are in charge that have all the right answers." She continued:

> We're one of the largest natural history museums in the world, and we have over 150 scientists and experts on staff that are constantly making contributions to

> science. And the science is always advancing but inherent in that is the idea that there's always room to revise, and update, and change as new information and findings become available. And I think that's reflected in our communication style. Just because we have a collection of almost 40 million specimens and objects doesn't mean that we have a Twitter follower that can't contribute something to the conversation, too. Just because we're sharing the knowledge of our experts doesn't mean we want to be talking through a megaphone. We want to be having a conversation and [to be] inspiring other people to join in on that and hopefully deepen and foster their understanding of science and the natural world.

The Field Museum wanted to bring others along on their "journey of discovery," she continued.

With that, the FieldMuseum.org's 2018 redesign moved the site from being organizational-chart focused to something that is more user-focused in its architecture. The goal behind this move was to "help people find the information they were looking for," explained Wigodner, and to "make the museum look like a fun and cool place to go." Wigodner's past work experience in more direct museum education and working retail during college gave her an accumulated understanding of the importance of a customer-focused approach (see Table 3). Wigodner wants everyone to have a good experience and enjoy the opportunity to learn "something new or build on knowledge they had before . . . a fact or a nugget." She explained it being part of her role to "constantly push for the best possible experience for our users," while also balancing a wide variety of stakeholder needs. One of Wigodner's favorite examples of this was when the website designer, from an outside firm, received feedback about some concerns from the Field Museum's accessibility consultant, another outside collaborator. That led

to an outcome that the designer admitted to being an improvement on his original design. Wigodner reflected, “I think that sometimes those moments of finding collaborators who can really work together—people who can iterate on something just try to do it a little bit better—have been some really wonderful moments” for her as a project manager, and as a “human who works with a lot of different people and is always trying to satisfy a lot of different priorities.” Wigodner felt good about opportunities like that where functionality, design, and content worked really well together in the end, even when that was not the case initially.

Uhrich and Wigodner both spoke to the importance of collaboration and working across departments. When scientists publish papers, the web and digital engagement team has worked with their colleagues in public relations to gather images and other related assets. If there were something that seemed particularly of interest to the museum’s followers, the digital team “set up a meeting with the scientist and [tried] to preempt some of the questions that they [knew would] come up” to be sure they were ready to respond when a new story was posted (K. Uhrich, personal communication, August 20, 2018). There were other times followers asked for help identifying a bug, and the social media team looked to scientists who studied insects to help answer the questions. Uhrich shared, “those relationships [across the organization] are really key and not to be underestimated.” She continued:

> In the way that our scientists rely on our knowledge of social media and communication strategies to best tell their stories and to share their work, we hugely rely on them to make sure that we're putting their work out there in the best, most factual way.

Relationships across the organization have been critical to sharing the new discoveries coming from Field Museum-supported scientists.

Given that the Field Museum is a strongly academic institution, Wigodner has found using research in more administrative work useful. She has used it to "inform the conversations that we have with other staff and the decisions that we make." Wigodner continued:

> I think that everybody has an opinion about how things look and function on the internet—because everybody uses the internet [and] social media. . . . I have been surprised at how much having [research-based] information can really help us make a case internally, as opposed to . . . saying, "Well, our designer thinks that this is the best decision."

Given this, Wigodner has had every intention of continuing more robust evaluation than they had in the past.

Evaluation. In the fall of 2016, the Field Museum did 10 longer-form, user-testing sessions to better understand how people looking for different things would navigate the site. A pop-up survey also asked all website visitors why they were visiting the site; more than 60% were planning a visit. Thirty seconds or a minute later, if the visitor had responded to the first question, a second question popped up asking if they found what they were looking for on the website. Anecdotally, this was understood to be a challenge of the site prior to the redesign. Wigodner said she found the pop-up survey results useful when the instrument was used on the old site, and she would like to run it again on the new site at some point. While the previous version of the Field Museum's website did not have the budget or buy-in for continuous improvement efforts, Wigodner believed that had changed and iteration would continue.

Given the recency of the new site launch, Wigodner explained, “We're still figuring out what that looks like into the future, in terms of how we track it, report on it, and act on it.” Wigodner mentioned that the website just launched less than 2 months prior to our conversation, so they were just starting to work on evaluating the new version. Wigodner explained:

> We’ve been working with the agency that we worked with on a redesign and build process to do an initial kind of dive into how our homepage and visit planning sessions are working. We've [also] been establishing some updated key performance indicators, KPIs, that we'll track and act on in the future.

She also said they would define other evaluation elements over time. Wigodner said, “There are certain things that we can easily do,” but determining if doing longer form user testing was worth doing is a challenge. Wigodner added, “We might not necessarily pick the right things yet.” She was concerned they simply did not know their new site well enough given the recency of its launch.

The basic evaluation metrics the Field Museum used with their website were things “like how many people are looking at the site, how long are they spending on it, and how many people come back” (S. Wigodner, personal communication, July 27, 2018). Wigodner continued:

> But in terms of answering questions like “Are people really discovering more around the site?” “Do they enjoy that?” “Are they actually learning from it?” I think those are the harder metrics. We've started thinking about how we might consider defining them, but haven't put all the pieces together on that yet.

On the social media side, the Field Museum has monitored user-generated content qualitatively and has looked at analytics about how hashtags are performing and the

numbers of engagements, for example. That is something that has changed over time; at the time of the study, the Field Museum saw social media engagement as much more important than the quantity of followers. When explaining what they value or measure related to engagement, Uhrich described, “You want somebody *liking* you, especially on Facebook. We want people sharing and commenting on our posts.” She also mentioned they valued having people on Twitter retweeting and asking questions. “It all comes down to having that conversation,” she continued, “but it happens in different ways on different platforms.” Uhrich explained, “We would much rather tweet 3 times a day and have those really spark some conversations and engage people than tweet 30 times a day and not get any response.” When it comes to social media, Uhrich has learned, “You can't do it all and you can't use it all.” She continued, “It's better to be in fewer places and putting out more meaningful content than trying to spread yourself really thin.”

Uhrich described her interest in using A/B testing, a method of randomly presenting two versions of something to website visitors to determine which is more effective. She would like to use A/B testing with different kinds of educational stories or other content to measure the differences in social media engagement. “There’s a lot that I wish we could do as far as customizing reports and learning more about our followers, just to get a better sense of what they're following us for,” Uhrich explained. She continued by explaining that they had the main Field Museum accounts, the SUE the T. Rex Twitter account, and Emily Graslie's The Brain Scoop (see Figure 10). Uhrich said she “would love to have a better understanding of how the three sets of followers overlap.”

Wigodner and Uhrich communicated a mutual desire to continue learning and growing in their roles for the benefit of the Field Museum and its visitors. They described

Figure 10. The three Twitter accounts connected to the Field Museum's outreach work (Field Museum, 2008; Field Museum, 2009; Graslie, 2008b).

taking a scientific approach to challenging projects, leading web design and communication innovations with data. Furthermore, their desire to contribute to and benefit from this study was humbling. This passion for their craft and their "pay it forward" approach was also demonstrated by the interviewees from NOAA.gov.

NOAA.gov. NOAA.gov is the website of the National Oceanic and Atmospheric Administration (NOAA), a federal government agency of the United States with an annual budget of approximately $6 billion whose scientific and outreach mission has included topics of climate, weather, oceans, and coasts (Cahlink et al., 2018). The breadth and depth of the NOAA's work makes the central outreach efforts both complex and critical. It also makes discussing NOAA.gov less straightforward than I had anticipated.

The following data on NOAA's web and social media design and evaluation was gathered through netnography and interviews. Netnographic participant-observational research was conducted over an approximately two-month period in 2018 on NOAA.gov, facebook.com/noaa, instagram.com/noaa, twitter.com/noaa, and youtube.com/user/noaa. A group phone interview was conducted with NOAA's Education Strategic Planning Specialist, Marissa Jones; Education Outreach Specialist, Bekkah Lampe; Digital Strategy Lead, Allison Soussi-Tanani; and National Outreach Coordinator, Robert

Hansen (see Table 4). Public reports found online served as a background resource in preparation for the interview. Lastly, interview participants were provided with a draft of this data analysis to ensure accuracy of the data's representation.

Design. NOAA.gov, Jones explained, is primarily a communications "product" and said it was really interesting to hear me say, "'Oh, what an educational website!" Internally at NOAA, there has been more of an organizational distinction between education and communication. Jones continued:

> NOAA.gov is a platform for us to bring those two components together and . . . bring all of NOAA, which takes on many, many different forms like the weather service, fisheries, sanctuaries, research programs, partnerships with universities, and so on, all together into one place. It's a merging opportunity for all of us.

This collaboration was evident in the way they internally arranged to have a four-person conference call phone interview, connecting from various locations and organizational departments.

Jones and Soussi-Tanani identified the update to a more "modern," "magazine-style" site design, recommended by an outside firm, "forced" a content iteration to web engagement best practices (M. Jones, personal communication, July 26, 2018). Jones shared that the role of the experts on NOAA.gov has been to curate and interpret. Jones referenced the role of those working on the website as curation three times and its related strategy of storytelling twice; Soussi-Tanani referenced the telling of stories seven times. Reviewing the variety of materials and opportunities shared by NOAA.gov, most of Anderson's (2008) interaction variables were used. Independent study content was used primarily, followed by community of inquiry opportunities (see Figures 11, 12, and 13). One paced collaborative learning example was identified deep into the site (see

Table 4

NOAA.gov Interviewee Demographics

Name	Position	Education	Years of Experience in the Field	Other Relevant Experience
Marissa Jones	Education Strategic Planning Specialist	Master's Degree in Aquatic and Fishery Sciences; Bachelor's Degree in Biology	4	2 years of marine science research; 2014 Knauss Marine Policy Fellowship
Bekkah Lampe	Education Outreach Specialist	Master's Degree in Ecology, Evolution & Marine Biology; Bachelor's Degree in Biology	10+	K-14 STEM Education Coordinator at a community college, Education Program Coordinator at a natural history museum, Lab Technician for aquatic research labs, and part time and volunteer positions at museums, aquariums, and nature centers; roles have included social media, website management, and graphics/video responsibilities
Allison Soussi - Tanani	Digital Strategy Lead	Studies in Visual Communications, Web Development and Design, Graphic Design	Not provided	Not provided
Robert Hansen	National Outreach Coordinator	Master's Degree in Library Science; Bachelor's in Geography	43 at NOAA, 10+ of which had some involvement with the website and social media	Cartographer, historian, and Technical Information Specialist, all at NOAA

Figures 11 and 14). This collaboration was evident in the way they internally arranged to have a four-person conference call phone interview, connecting from various locations and organizational departments.

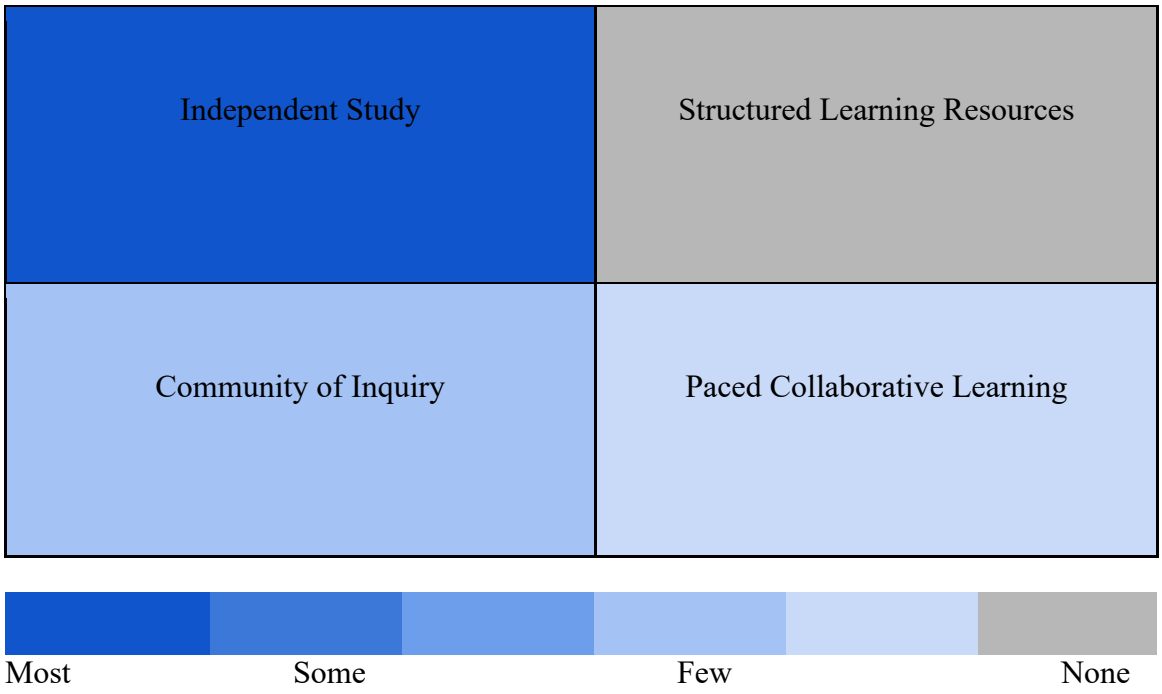

Figure 11. Heat map of Anderson's interaction variables identified on NOAA.gov and related social media sites.

Figure 12. Example of independent study resource from NOAA's Twitter account (NOAA, 2018a).

Jones and Soussi-Tanani identified the update to a more "modern," "magazine-style" site design, recommended by an outside firm, "forced" a content iteration to web engagement best practices (M. Jones, personal communication, July 26, 2018). Jones

Figure 13. Example of community of inquiry from NOAA's Twitter account (NOAA, 2018b).

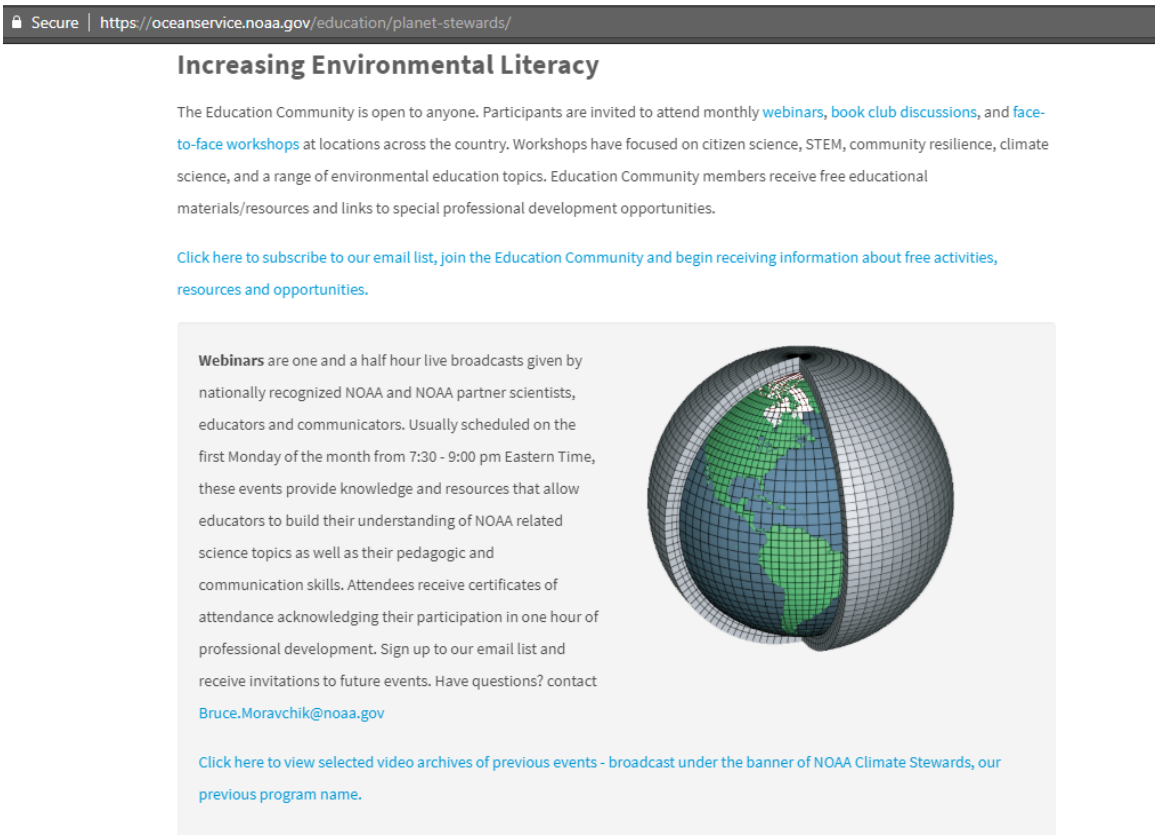

Figure 14. Example of paced, collaborative learning from NOAA found deep into the site (NOAA, n.d.-b).

shared that the role of the experts on NOAA.gov has been to curate and interpret. Jones referenced the role of those working on the website as curation three times and its related strategy of storytelling twice; Soussi-Tanani referenced the telling of stories seven times. Reviewing the variety of materials and opportunities shared by NOAA.gov, most of Anderson's (2008) interaction variables were used. Independent study content was used primarily, followed by community of inquiry opportunities (see Figures 11, 12, and 13). One paced collaborative learning example was identified deep into the site (see Figures 11 and 14).

Jones shared, "People often ask, 'How can I use NOAA data in my classroom?' Or, [say] 'I want weather data,' or, 'I'd like ocean data.'" There is a massive amount of data available, according to Jones:

> You can find anything you want but it's almost so big that if you just give that link to someone, they aren't going to know what to do with it. I don't know what to do with it. And we kind of use this benchmark of like, well, if I'm stumped when I get to a resource where there's so many options, other people are probably gonna feel the same way.

Jones explained that they get these kind of questions often enough to understand people are looking for "something specific and actionable," so instead of sharing everything, they try to share the best resources, playing a "role in helping them to something that they can use more immediately." This is curation. Jones specifically referenced "curation" three times in our interview, in addition to this reference of sharing the "best" resources rather than "everything." One way they do this is through tagging content topics to develop an automated way of sharing related content and helping website visitors "delve a little deeper into content if they want," explained Soussi-Tanani.

Soussi-Tanani has found it difficult to keep NOAA employees across the organization engaged in the website and actively creating new content. One of the goals of the website redesign included implementing a content management system that would allow subject matter experts to be closer to the content publishing, decreasing the time to publish, and increasing content accuracy. The website redesign at NOAA.gov was headed by the Office of Communications and three primary individuals. Jones described internal benefits from the process of making the new NOAA.gov website happen as having created "opportunities for us to work together [across departments]." Jones continued, "I think about how offices that are normally completely separate from one another actually do have connections and could use similar content types or templates . . . collaborate on

topics and [make] connections across our organization." This is an example of an unanticipated benefit from the website revision.

Evaluation. Soussi-Tanani shared that before the redesign, NOAA.gov's bounce rate was in the 70 to 80 percentile. A bounce rate is defined as the percentage of website visits where visitors navigate away from the site after viewing a single page. Typically, website designers want to encourage multiple page views and see low bounce rates as a sign visitors are successfully drawn in and are choosing to engage with the content on a website. Fortunately for NOAA, the new site consistently has a 15 to 20% bounce rate, "which means people are coming in and actually ingesting the information on the site, and hanging around for a while," explained Soussi-Tanani. Screenshots illustrate the homepage evolution (see Figures 15 and 16).

Jones explained, "We don't do much evaluation beyond Google Analytics. But we actually would love to know what do other people do, or what else could we be doing." Lampe echoed Jones's comment sharing that they were looking forward to learning from this research project. "From the educational standpoint," Jones explained,

> We would love to know how many people are using our resources . . . particularly when it's something that [website visitors] take back and use in some other setting like a curriculum, for instance. How many people are integrating it? How did they? How many people came through our site to ultimately use a resource that's on a different NOAA site? Like NOAA fisheries, or weather service, or something.

Jones described the Paperwork Reduction Act, which is designed to limit the paperwork burden of citizens, as preventing NOAA from studying the effectiveness and utilization of their web content. Any questions they asked the public for evaluation or

Figure 15. NOAA.gov homepage screenshot from January 17, 2014 (NOAA, 2014).

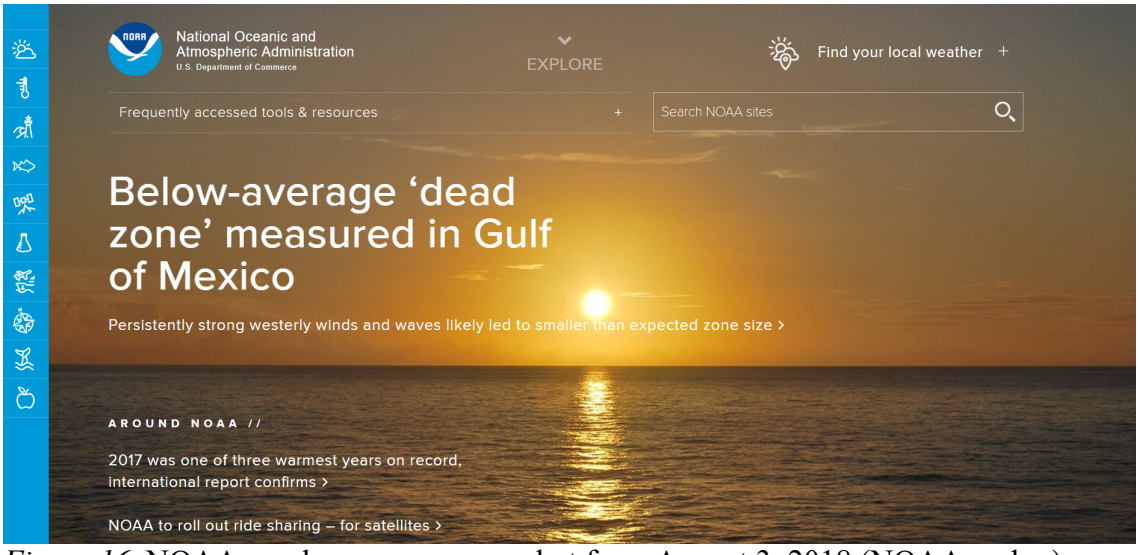

Figure 16. NOAA.gov homepage screenshot from August 3, 2018 (NOAA, n.d.-a).

research had to first be vetted to ensure they would not be encumbrances to the public. The staff at NOAA.gov struggled to have the fiscal and human resources to evaluate its online presence and act upon findings. However, they have started to prioritize this work. At the time we spoke, Jones was in mid-analysis of the NOAA education department's variety of their target audience demographics, including educators, students, parents, scientists, and the media. Additionally, NOAA.gov planned to use a pop-up, opt-in survey tool to learn more about public satisfaction with the resource and whether people were finding what they were looking for on the website. Soussi-Tanani shared:

> From a usability aspect, the government provides something called usability.gov where they have services available to us to do extensive focus groups and [gather] user feedback. . . . That is really something that I think we'd like to do . . . delving further into the customer satisfaction management tool.

NOAA's evaluation plans were in development at the time of our conversation. They would have liked to know what other people were doing in regards to evaluating informal, online learning and indicated they were likely to consider making future plans based on those findings.

Connection of the Interview Results and the Literature Review

The literature review was the basis for building the codes in this study. There were three categories: theoretical perspective, evaluation strategies, and research foci. These three areas make up a research discipline (Ellenbogen et al., 2004). The theoretical perspective was based on Anderson's (2008) proposed interaction variables of online learning: independent study, structured learning resources, community of inquiry, and paced collaborative learning. Codes for evaluation strategies and research foci, on the other hand, were developed from the whole of the literature review. The evaluation

strategy codes, representing the diversity of strategies I found in studies related to informal online learning, included surveys or questionnaires, textual analysis, interviews, observation, analytics or log files, social network analysis, focus groups, and pre and posttests. Likewise, the research foci were determined by the breadth of informal online learning research studies in the review. These are unique user count, content appraisal, stage of behavior change, RE-AIM, time spent, learning outcomes, and enjoyment. Most of the codes were represented in the case studies; some of the codes from the literature review were not. The theoretical perspective category granted the greatest opportunity to discover the intersection of learning theory and communications theory.

Theoretical perspective. The theoretical perspective was challenging to code (see Table 5). While learning theory focuses on interaction variables and the relationships present during the learning, the discussion interviewees shared about the ways in which they think about the content and website design intersected with these ideas. However, the communication, web, and education practitioners at the organizations studied used an entirely different vocabulary, namely *storytelling*, *curation*, and *interpretation*. These ideas primarily correspond with the interaction variable of Independent Study. Some of the Independent Study resources are sequenced and directed, therefore come close to the interaction variable of Structured Learning Resources (Anderson, 2008). However, Anderson (2008) also required learning objects to be credentialed in a formal education system to be considered structured. Science storytelling and curated and interpreted resources may be structured in a sequenced and directed way, yet it would not be credentialed. Therefore, it would be coded as Independent Study. Little found on FieldMuseum.org or NOAA.gov would go as far as being termed Structured Learning Resources. No Structured Learning Resources were discussed in the interview, but one,

Table 5

Theoretical Perspective Codebook

Subcategory	Code	Definition	Examples
Interaction Variable-Independent Study	TP.IV.Independent	Learners "interact directly and spontaneously with any content that they find, in multiple formats and especially on the Web" (Anderson, 2008, p. 60).	Jones shared that the role of the "experts" on NOAA.gov is to curate and interpret.
Interaction Variable - Structured Learning Resources	TP.IV.Structured	Learning that is "sequenced, directed, and credentialed through the assistance of a teacher in a formal education system" (Anderson, 2008, p. 60).	None found.
Interaction Variable - Community of Inquiry	TP.IV.Community	A "community of inquiry, [uses] a variety of net-based synchronous and asynchronous (video, audio, computer conferencing, chats, or virtual world) interactions. These environments are particularly rich and allow for the learning of social skills, collaboration, and the development of personal relationships among participants" (Anderson, 2008, pp. 60-61).	Wigodner shared, "Social [media] is a bit more of a conversation that we have *with* people" than the website itself.
Interaction Variable - Paced Collaborative Learning	TP.IV.Paced	A community that "binds learners in time, and thus forces regular sessions — or at least group-paced learning" (Anderson, 2008, p. 61).	The Field Museum's digital learning team previously brought scientists into classrooms for interactive conversations through video calls, but has pivoted away from this strategy (S. Wigodner, personal communication, July 27, 2018).

Weather-Ready Nation Ambassadors, was incidentally discovered deep through the NOAA.gov website, actually on weather.gov. Likewise, Paced Collaborative Learning, defined as a community that "binds learners in time, and thus forces regular sessions—or at least group-paced learning" (Anderson, 2008, p. 61) was not represented in the given cases. In fact, the only time it was referenced was by the Field Museum's

acknowledgment that their only online synchronous collaborative learning opportunity had been phased out due to a shift in priority toward the creation of YouTube videos. A Community of Inquiry that allowed for learner interaction online, synchronously or asynchronously, was found on social media sites connected to the case studies. These "environments are particularly rich and allow for the learning of social skills, collaboration, and the development of personal relationships among participants" (Anderson, 2008, pp. 60-61). However, this was identified through netnographic observation more so than through the research interviews.

Evaluation strategies. Evaluation strategies were less challenging to code than the theoretical perspective, because the vocabulary used is more aligned (see Table 6). There was also a greater variety of approaches in this coding area than in the theoretical perspective. Of the eight evaluation strategies cited in the literature review, six were identified in the case study interviews. There is limited focus in this area given the emergent nature of the discipline.

Rather than approaching the interviews with a checklist of what I had anticipated finding, an interview guide was used for an open-ended approach. I think this is particularly important when getting at the research foci. When discussing how each organization measures the impact of their online outreach, interviewees were asked, "What do you look to understand and/or what is the impact you want to measure?" After follow up questions related to foci and methodology, interviewees were also asked, "What else would you do, if it were feasible?" To my surprise, enjoyment was the most often discussed research foci. Enjoyment has not historically been on the top of most education researchers' list of priorities. However, given the voluntary nature of informal online learning, perhaps I should have anticipated it to be the obvious winner, especially

Table 6

Evaluation Strategies Codebook

Subcategory	Code	Definition	Example
Surveys / Questionnaires	ES.Survey	A measurement of experiences and opinions by asking a series of questions in a written format.	Before their redesign, a pop-up survey at FieldMuseum.org simply asked people why they were visiting the site. Thirty seconds or a minute later, a second question popped up if the visitor had responded to the first question asking if they found what they were looking for (S. Wigodner, personal communication, July 27, 2018).
Textual Analysis	ES.TextAnalysis	A description and interpretation of written messages.	"We have the ability to do text analysis in this new tool. And so that is something that we'll be looking to do . . . pulling in data from our social media sources and then analyzing it against what we find," explained Soussi-Tanani who will rely on a contractor with expertise in this area to plan and conduct the analysis.
Interviews	ES.Interviews	A measurement of experiences and opinions by asking a series of questions in a verbal format.	None found.
Observation	ES.Observation	In this context, observation is a method that entails watching, in person, or through screen recording, a person use an online resource.	In the fall of 2016, the Field Museum did about 10 longer form user tests to better understand how people looking for different things would navigate the site (S. Wigodner, personal communication, July 27, 2018).
Analytics / Log Files	ES.Analytics	Patterns in data related to who visits, and how they move through online sites.	Soussi-Tanani shared that before the redesign, NOAA.gov's bounce rate was in the 70 to 80 percentile while the new site consistently has a 15 to 20% bounce rate, "which means people are coming in and actually ingesting the information on the site, and hanging around for a while."
Social Network Analysis	ES.NetworkAnalysis	An investigation of social structures through network and graph-based analysis.	Doing an analysis of Twitter followers, Jones found the platform was helping NOAA's Education department reach a variety of their target audience demographics, including educators, students, parents, scientists, and the media.

(continued)

Table 6 (cont'd)

Evaluation Strategies Codebook

Subcategory	Code	Definition	Example
Focus Group	ES.FocusGroup	A group interview typically used to gather opinions and attitudes about a product, service, or concept from a target demographic.	"We also did a series of focus groups with staff. We did, I think, about eight groups of like 10 people each, that were 90 minute discussions. We ran these with Expose Your Museum, a consulting firm to really get a sense of what the pain points were for staff, how are people reacting, and what kinds of conversations they were having with visitors or people who got in touch with their departments," said Wigodner.
Pre and Posttest	ES.PrePostTest	Pre and Posttests are a way to ask knowledge-based questions before and after a learning opportunity to measure knowledge gain.	None found.

given enjoyment comes, in part, from ease of use (Lin & Gregor, 2006). On the other hand, while I had anticipated hearing someone in the case study interviews discuss the desire for some kind of behavior change based on scientific knowledge, none did. The other seven research foci found in the literature review were discussed in the interviews.

While the RE-AIM framework was not mentioned by name, when interviewees referenced ideas beyond user counts or time spent, and related to reach, effectiveness, adoption, implementation, and/or maintenance, the utterance was coded as RE-AIM. Table 7 lists the codes with associated definitions and examples from the interviews.

Emerging Themes and Patterns

After coding research interviews, epistemic network analyses (ENA) informed my understanding of emerging themes and patterns in the data. An ENA is a quantitative ethnographic technique for modeling the connections between codes, producing networks that can be compared both visually and statistically. ENA was originally designed to address challenges in learning analytics (Shaffer et al., 2009). It is an analytic approach

Table 7

Research Foci Codebook

Subcategory	Code	Definition	Example
Unique User Count	RF.UserCount	The unique user count is the number of individuals who visit a website.	"[W]e know that we reach a larger audience online than we reach in person, at the museum. I think we had 1.6 million visitor in 2017 and we have more than two million, maybe two and a half million online visitors," shared Wigodner.
Content Appraisal	RF.ContentAppraisal	Content appraisal is a qualitative review of content strategy; this may include things such as tone, interrelatedness, relevance, usability, and actionability.	A team of five people working in digital content and engagement rewrote all of the content for sections of the website. Previously, departments all around the Field Museum wrote their own content and published it without any coordinated review (S. Wigodner, personal communication, July 27, 2018).
Stage of Behavior Change	RF.StageOfChange	Behavior change is understood by behavioral scientists as an intentional process that involves "progression through five stages—precontemplation, contemplation, preparation, action, and maintenance" (Prochaska, DiClemente, & Norcross, 1992, p. 1)	None found.
RE-AIM	RF.REAIM	The acronym stands for Reach, Effectiveness, Adoption, Implementation, and Maintenance. This framework was designed to look at impacts of public health initiatives.	"From the educational standpoint," Jones explained, "we would love to know how many people are using our resources . . . particularly when it's something that [website visitors] take back and use in some other setting like a curriculum, for instance. How many people are integrating it? How did they? How many people came through our site to ultimately use a resource that's on a different NOAA site? Like NOAA Fisheries, or weather service, or something."
Time Spent	RF.TimeSpent	Time spent is a basic metric of how long a visitor spends on a website.	The basic evaluation metrics the Field uses with their website are things "like how . . . how long are [visitors] spending on [the website]" (S. Wigodner, personal communication, July 27, 2018).

(continued)

Table 7 (cont'd)

Research Foci Codebook

Subcategory	Code	Definition	Example
Learning Outcomes	RF.LearningOutcomes	Learning outcomes are changes in knowledge or skill as the result of an experience.	"But in terms of answering the questions like 'Are people really discovering more around the site?' 'Do they enjoy that?' 'Are they actually learning from it?' I think those are the harder metrics. We've started thinking about how we might consider defining, but haven't put all the pieces together on that yet," Wigodner explained.
Enjoyment	RF.Enjoyment	"Enjoyment" means the meeting and fulfillment of a person's needs; online, this includes the concept of findability and usability.	"From a usability aspect, the government provides something called usability.gov where they have services available to us to do extensive focus groups and [gather] user feedback . . . that is really something that I think we'd like to do . . . delving further into the customer satisfaction management tool," shared Soussi-Tanani.

that argues the connections made in discourse are an important level of analysis (Shaffer et al., 2009). The ENAs supported my understanding specifically about the relationships of the coded themes. In uncovering the ways in which practitioners think about a new discipline, from design to evaluation, seeing these connections is essential.

FieldMuseum.org. An ENA of the Field Museum interview evaluation strategies and research foci codes identified a network of connections that centered on an artery from the research foci of Enjoyment to Content Appraisal (see Figure 17). Another strong connection was the relationship between the evaluation strategy of Analytics and the research focus of User Count (see Figure 17). Furthermore, the evaluation strategy of Analytics and the research focus of Enjoyment were very closely related, as demonstrated by their proximity in the diagram (see Figure 17).

An ENA of the Field Museum interviewees' thinking around all three aspects of a disciplinary matrix, theoretical perspective, evaluation strategy, and research foci, is represented by Figure 18. The largest node, representing the most frequent mentions, is

Figure 17. ENA model of Field Museum interviewees' thinking around evaluation strategies and research foci.

now the theoretical perspective of Independent Study. The central most element of the figure with the most connections to other ideas was the research foci of Enjoyment.

NOAA.gov. An ENA of the NOAA interview evaluation strategies and research foci codes identified a network of connections that centered on two arteries from the research focus of User Count to the evaluation strategy of Analytics, and the research focus of Content Appraisal to the research focus of Enjoyment (see Figure 19). Furthermore, the evaluation strategy of Analytics and the research foci of Enjoyment were in close proximity, representing a close relationship between them (see Figure 19).

An ENA of NOAA interviewees' thinking around all three aspects of a disciplinary matrix, theoretical perspective, evaluation strategy, and research foci, is

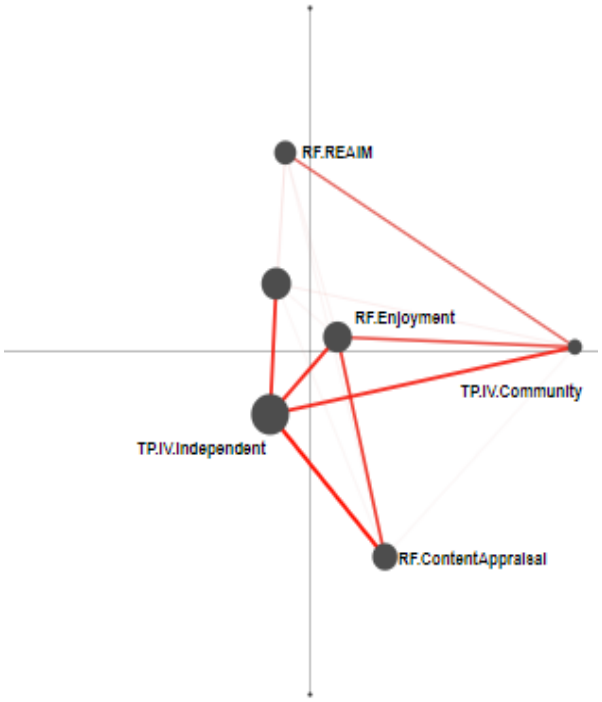

Figure 18. ENA model of Field Museum interviewees' thinking around all three aspects of a disciplinary matrix: theoretical perspective, evaluation strategy, and research foci.

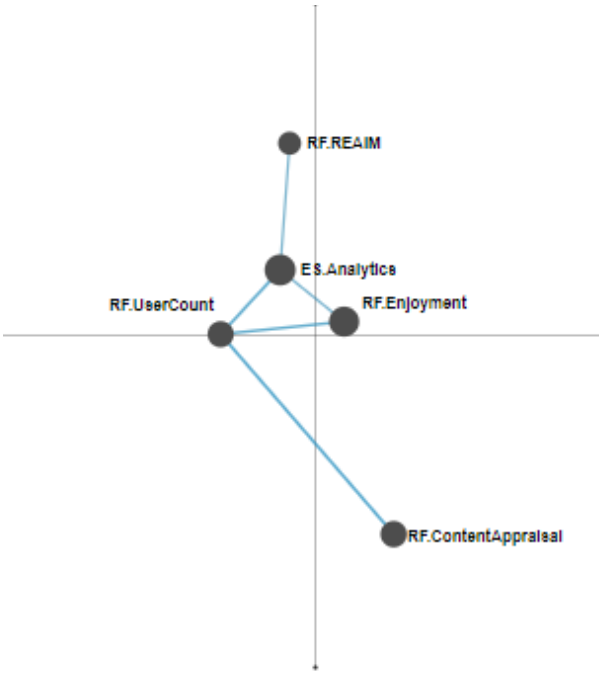

Figure 19. ENA model of NOAA interviewees' thinking around evaluation strategies and research foci.

illustrated by Figure 20. When taken together, the central most elements were the theoretical perspective of Independent Study and the evaluation strategy of Analytics, where both are also closely connected to the research foci of Enjoyment and User Counts (see Figure 20).

The most prominent themes coming through in the ENAs was the connection of the theoretical perspective of independent study with the research focus of Enjoyment and the evaluation strategy of Analytics. The proximity of Enjoyment and Analytics in Content appraisal and RE-AIM were also prominent research foci in the interviews, but each graphical representation surprised me. Enjoyment seemed like a more qualitative research foci that I would have judged to be misaligned with Analytics. However, in the informal learning context, using Analytics to learn how and how much visitors engage with your platforms and content can provide a useful window into the joy, or lack thereof, they find in doing so. This is particularly so in the independent study space, where willingness to return and engage could not be connected with responsibility one might feel to a Community of Inquiry or a facilitator of learning.

Summary

This chapter shared the results of individual case studies with a qualitative narrative and graphical representations. To round out the QE approach, the individual case studies are compared and contrasted in the Chapter 5 discussion. The results were shared with a focus on identifying how public websites and related social media are designed to serve as learning spaces for informal, self-directed adult learning, and the metrics that are used to evaluate learning and behavior-change associated with public websites. These data are revisited in a collective manner in the next chapter to support the development of a pedagogical model for the development and evaluation of public

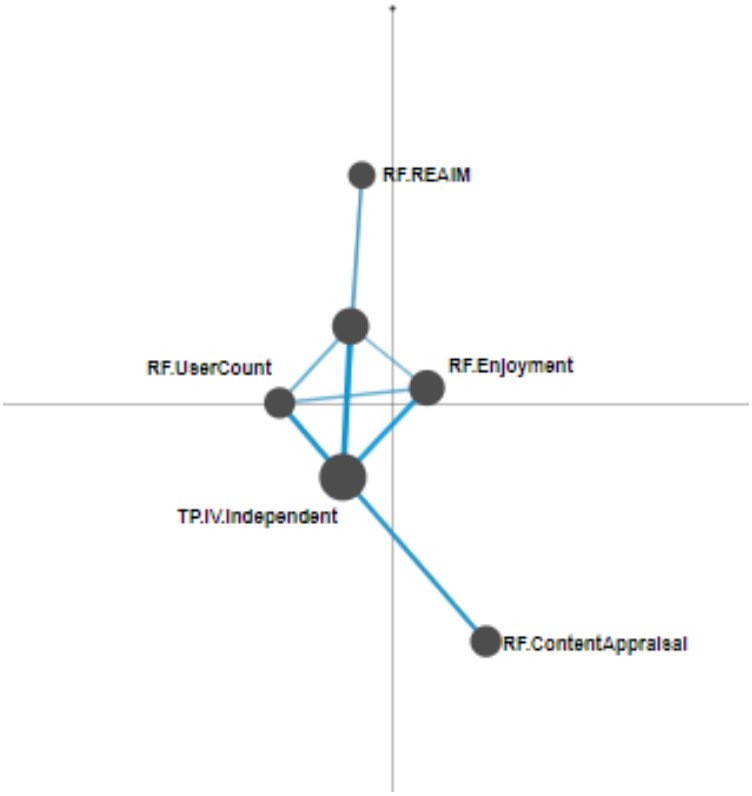

Figure 20. ENA model of NOAA interviewees' thinking around all three aspects of a disciplinary matrix: theoretical perspective, evaluation strategy, and research foci.

websites that seek to educate a general adult audience. Chapter 5 concludes with a discussion of the study's implications for practice, unanticipated conclusions, limitations, and recommendations for further research.

CHAPTER FIVE

No one has more sweeping influence on the ship than the designer.

Senge (2006, p. 321)

Conclusion

This study was designed to investigate how organizations design and evaluate educational outreach websites and related digital content for informal learning. I found there was an emerging discipline with similar theoretical perspectives that inform the approach to content and website design. The evaluation strategy and research foci were less developed than the theoretical perspective; practitioners were aware of this and were ready to learn how to take this to the next level but the needed expertise and related resources were underdeveloped too.

My overarching research question in this study was: How do scientific outreach organizations think about and implement a version of public pedagogy online? To get to this answer, I investigated the following research subquestions:

- How are public websites designed to serve as learning spaces for informal, self-directed adult learning?
- What metrics are used to evaluate learning and behavior-change associated with public websites?

The study identified that public pedagogy for the web could be defined as website and content design with a focus on curating, question answering, and storytelling (e.g., interpreting data). Web article tagging, website navigation, and social media posts have a strong impact on directing informal online learning. While the tagging and website navigation findings support the findings of the literature review, using social media posts as a tool to direct informal online learning was not found in the literature (Ally et al.,

2006; Bear, 2012; Starasts, 2015). Furthermore, it was observed that YouTube and Twitter fostered the most interaction opportunities for learners, which were also new findings not identified in the literature review. Practitioners in the study had fairly clear visions for their web and content design.

Evaluation strategies were less developed. The organizations studied used basic web analytics and pop-up surveys. While noting it is not a measure of learning, the use of web analytics as an interim measure of a resource's success was supported by the literature review (Skyrme, 2001). Evaluation was conducted with a focus on questions of enjoyment, user counts, content appraisal and elements of RE-AIM beyond reach, in that order (see Figure 21). This variety of approaches was supported and exceeded by the literature review, illustrating the lack of evidence available to support a specific approach to evaluation in this field. Practitioners knew there was more to do but were unsure of effective strategies that they had the resources to employ.

Implications for Practice

There was an emerging disciplinary matrix that could define the public pedagogy for informal online learning. This was determined through a quantitative ethnographic analysis. The previous chapter shared narrative descriptions and ENA graphical representations. This chapter completes the analysis by sharing additional ENA diagrams comparing the networks of the Field Museum and NOAA's theoretical perspectives, evaluation strategies, and research foci as shared in the interviews. See Appendix H for details on the ENA theory and methods.

Epistemic Network Analysis

Network representations of each organization's thinking around the disciplinary matrix of informal online learning illustrate both similarities and differences between the

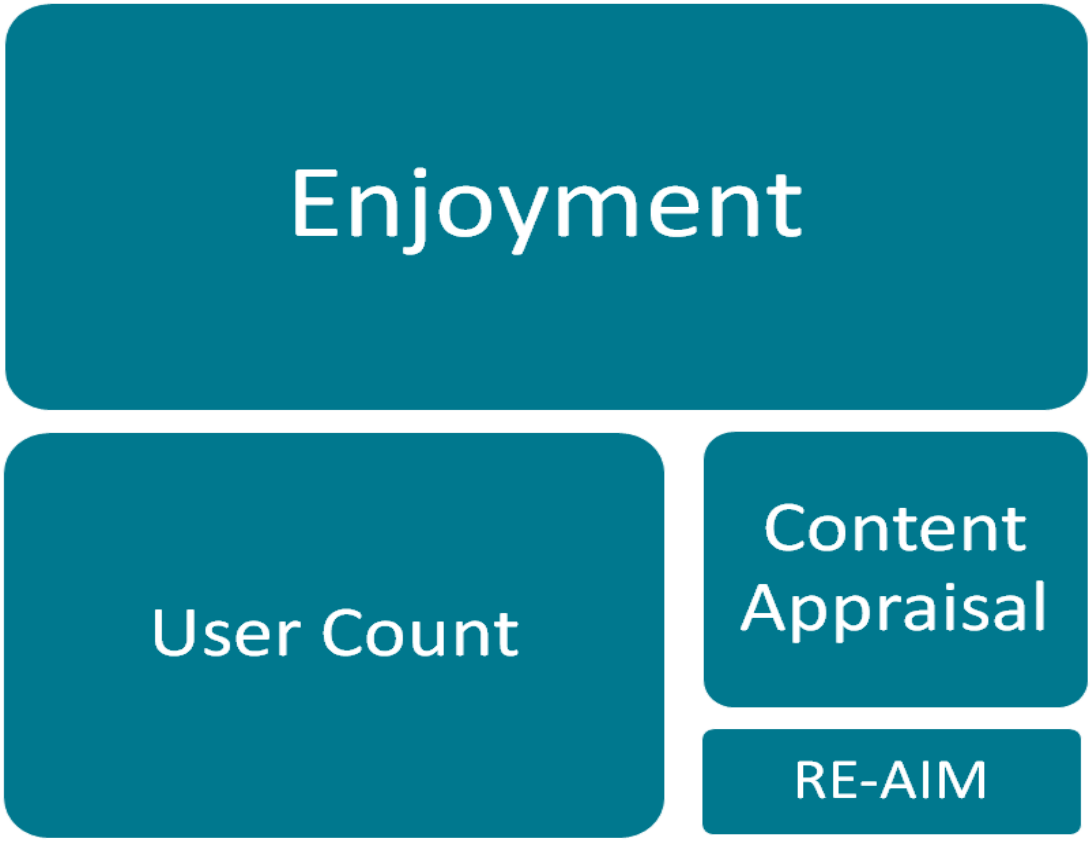

Figure 21. Table hierarchy illustrates the current research foci of the case studies.

two cases studied. Thicker lines indicate stronger and more frequent connections between the topics. The points represent the centroids of each group's network. The square represents the means of the points. Each model includes only the most significant nodes for clarity of presentation. The overlaid diagram (see Figures 22 and 23) and the underlying quantitative analysis (see Appendix H) of each organization's epistemic network provides both visual and statistical opportunities to further review the data from this study. However, it is important to note that the model is over-fit and therefore there are other possible conclusions. While the location of the nodes could be different, putting the statistical interpretation of the dimensions in question, the strength of the connections between any two nodes for any network remains the same. The *n* in this study is too small to claim statistical significance. However, the purpose of the ENA model in this case is to

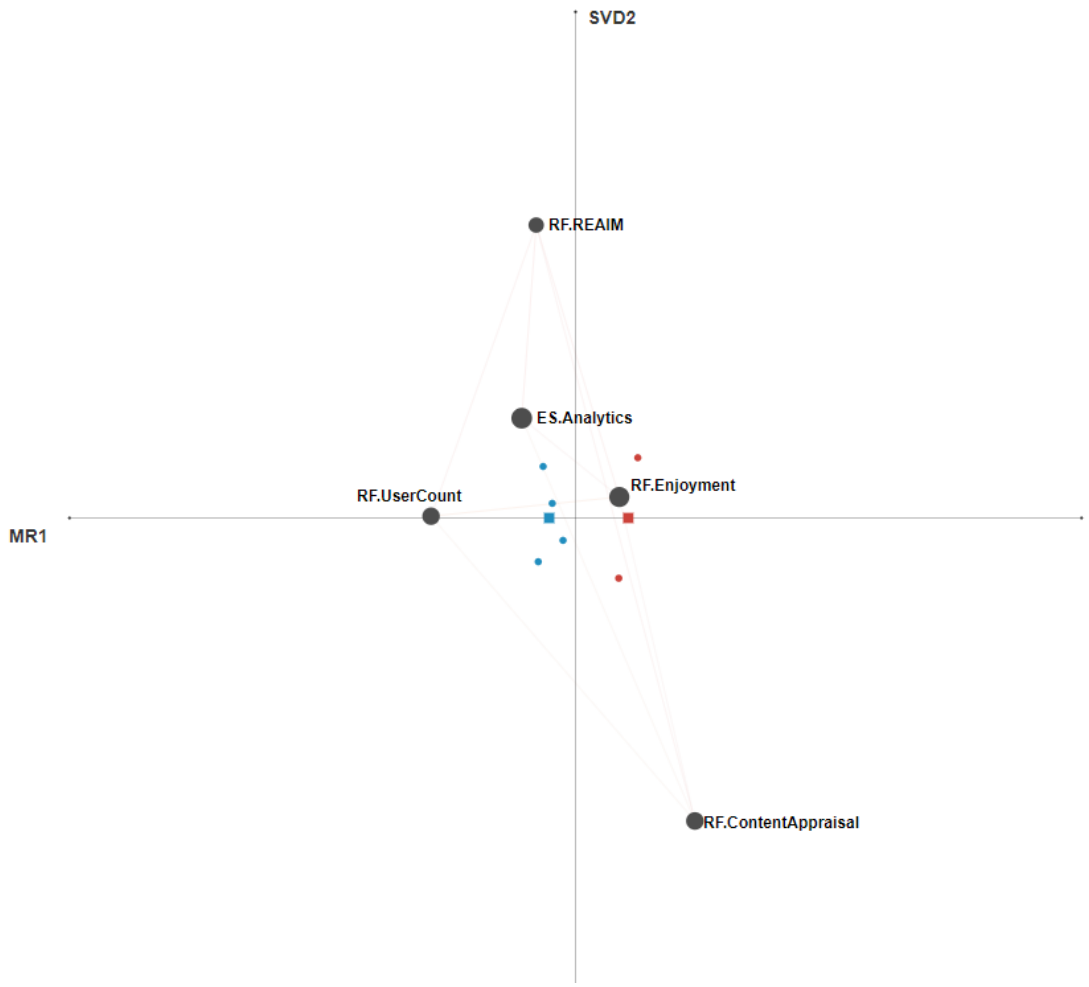

Figure 22. ENA model comparing the Field Museum and NOAA's interview responses around the evaluation strategy and research foci in their informal online learning.

make a representative model of the data to support the qualitative analysis; the dimensions become a way to highlight the differences in connections, rather than a mathematical representation of that difference.

In looking only at the evaluation strategies and research foci discussed in interviews with the Field Museum and NOAA employees (see Figure 22), the first dimension (MR1) accounts for less of the variance in the data than the second dimension (SVD2). A lower score on Dimension 1 indicates more connections to the research foci of user count and a lower score on Dimension 2 indicates more connections to the research foci of content appraisal. NOAA's interviewees referred more frequently to a

Figure 23. ENA model comparing the Field Museum and NOAA's interview responses around all three aspects of a disciplinary matrix: theoretical perspective, evaluation strategy, and research foci.

desire to measure user counts than the Field Museum's did, which is why on the first dimension NOAA's blue centroid is plotted further to the left than the Field Museum's red centroid. Meanwhile, a similar research interest in topics surrounding RE-AIM,enjoyment, and content appraisal, with similar web analytic evaluation strategies, kept the two centroids aligned vertically on the second dimension.

Likewise, when the theoretical perspectives discussed in interviews with the Field Museum and NOAA employees is included in the ENA model (see Figure 23), the first dimension (MR1) accounts for less of the variance in the data than the second dimension (SVD2). A higher score on Dimension 1 indicates more connections to a theoretical

perspective focused on the interaction variable of communities of inquiry. A higher score on Dimension 2 indicates more connections to the research foci of RE-AIM. The Field Museum's interviewees referred more frequently to a focus on community learning than NOAA's did, which is why the Field Museum's red centroid is plotted further to the right than NOAA's blue centroid. There was a difference between research foci networks on the first dimension between the Field Museum's staff and NOAA's. However, a similar research interest in topics surrounding RE-AIM, enjoyment, and content appraisal, with similar web analytic evaluation strategies, and a theoretical perspective focused on independent study again kept the two centroids aligned vertically on the second dimension.

In summary, the combined ENAs identified more similarities than differences in the case studies. The theoretical perspective of Independent Study was a constant, primary element in the interviews with both organizations. They diverged in that the Field Museum placed a greater emphasis on the theoretical perspective of Community Learning while NOAA more frequently mentioned the research foci of User Counts. On the other hand, for both organizations, the evaluation strategies discussed were diverse, with most having few connections to other conversation elements. The research foci of enjoyment was the most central to the interview conversations, with the most connections to other elements. In an emerging field such as this, it is not surprising to have differences accompany the similarities identified.

Disciplinary Matrix

There are three elements in the disciplinary matrix used in this study: theoretical perspective, evaluation strategies, and research foci (Ellenbogen et al., 2004). The theoretical perspective for those creating informal online learning resources was

primarily a focus on independent learning, with some utilization of the community learning possible on social media platforms. Social media sharing of educational content (i.e., videos, articles, interactives) fostered organic, pop-up communities of inquiry around discrete topics. The narrative description in Chapter 4 illustrated examples of the case study organizations' platforms and content designs, which shed more light on specific commonalities in the theoretical perspective. These organizations planned and developed content in a way that told stories, enabled search, answered questions, curated the best resources, interpreted data and information, and guided discovery through article tags. Therefore, public pedagogy for the web could be defined as website and digital content designed with a focus on curation, question answering, and storytelling for the curious public.

Development of evaluation best practices to measure learning outcomes related to website and social media content is needed. In this study, research foci were unfocused and evaluation strategies were limited and unsophisticated. The organizations studied used basic web analytics and pop-up surveys and had ambitions of adding more user testing. With research foci weighted toward enjoyment, user counts, content appraisal, and elements of RE-AIM beyond reach, I suspect the questions practitioners were seeking to answer were limited by their current understandings of what they could hope to measure with known resources. Practitioners had a vague understanding there was more evaluation their work would benefit from, but the expertise and tools to evolve their practices were not readily available.

Recalling the literature review's definition of learning as "a behavioral change resulting from individual information processing," the RE-AIM framework may be a useful strategy to employ in this context (Hoffmann & Koch, 1998, p. 161). Named for

its strategy of measuring a resource's reach, effectiveness, adaptation, implementation, and maintenance, the interviewees mentioned many of RE-AIM's elements without referencing RE-AIM directly, nor seeming to know how to feasibly gather related data beyond reach. While their planned pop-up surveys may be useful in garnering some of this data quickly, purposively sampled focus groups may result in deeper measures on the RE-AIM framework when time and resources allow. Case studies using this strategy in the online outreach education context would be useful to validate or disprove this idea.

Unanticipated Conclusions

The first unanticipated conclusion of this project centers on organizational culture and development. It is apparent readiness for larger organizational change and collaboration is required for the re-visioning of an outreach website with a new focus on informal learning. Organizations have clear distinctions between communication and education functions that do not hold up in the creation of digital content shared openly online. On a similar vein, while I had anticipated websites themselves and their related social media accounts to be cohesively planned and evaluated, they were not. They were owned by different positions and were not collaboratively managed, even when those positions were housed in the same department. The positions communicated regularly about new content and upcoming events but maintained boundaries around roles that may need to come down as evaluation practices evolve. Those navigating these boundaries and developing collaborations, arguably leading in this field, were of women around age 30 with master's degrees and backgrounds in direct education more so than communications or research, as observed in this limited case study. Some were paid as contractors, rather than being employees with benefits and protections. In all cases, these women held roles that have become highly interdisciplinary.

Another unanticipated outcome was the finding that the market is ripe for this research. Both organizations were eager to hear what others are doing in the area of evaluation. Lampe and Jones both mentioned this interest specifically. When discussing evaluation, Lampe said, “We look forward to your research and we would like to know what other people are doing . . . it could be very interesting for us to see what other people are doing and then maybe make some future plans based on that.” Similarly, Jones explained, “We don't do much evaluation beyond Google Analytics, but we actually would love to know what do other people do, or what else we could be doing.” Wigodner’s interest was less overt, but after acknowledging there is a lot they did not yet know about how to best evaluate their new website, she said she thought this dissertation was a “cool project” and inquired about the other organizations included in the collective case study. Wigodner also mentioned the value she has found in doing original research to make decisions and develop buy-in; given the Field Museum’s culture as an academic institution, using research in her work had informed the conversations and built support around decisions internally far more than simply relying on the recommendations of an outside designer.

Limitations

This study was primarily limited by its number of cases. I was fairly easily able to connect with individuals at fieldmuseum.org and NOAA.gov. Meanwhile, I spent a lot of time trying to connect with the right person or people connected to Foodsafety.gov without success. After it became clear I would be unlikely to find interviewees related to Foodsafety.gov, I also made unsuccessful attempts to connect with aqua.org and WWF.org. While I originally proposed studying three organizations, it quickly became unfeasible.

Another limitation was my reliance on those I was able to connect with at the organization to self-identify who would participate in the interviews based on their understanding of my study. While the representation was fairly robust, it is important to note that the Field Museum interviews included their social media manager while NOAA's did not. However, NOAA included individuals from the education team while the Field Museum did not. While neither was right nor wrong, they potentially held different knowledge and perspectives.

Recommendations for Research

The clearest outcomes of this study are the identified needs for the development of evaluation methods that reliably and efficiently measure outcomes of informal learning on outreach websites and related social media presences. If public pedagogy for the web can be defined as websites and content design with a focus on curating, question answering, and storytelling, then evaluation methods common to curation, findability, and storytelling might be useful frameworks from which to begin. On a related note, future research should also consider the opportunities and risks created when resources are curated online. While online algorithms allow opportunities to provide helpful customized learning experiences, they also can provide unequal experiences (O'Neil, 2016). When curating resources, it is important to consider what the potential impacts of metadata-driven inclusion and exclusion of resources might be. In any case, when looking to understand the impact of informal online learning opportunities, we must ask, Who benefits from the learning opportunity and who does not? This is especially true when those opportunities are publicly funded.

Plan for Communicating and/or Using the Results

Throughout this study, I have had the opportunity to use the results in my daily work, helping strategize and implement the future of Extension Education at the University of Minnesota. While writing the final chapter of this dissertation, I also shared my results through a research poster at University of Minnesota Extension's annual program conference. Furthermore, I intend to use this study as an initial step in my overall research agenda. Since identifying the lack of established evaluation best practices in this area, I have grown an interest in further investigating what they could or should become. I intend to grow my scholarship around this area until I can credibly write a narrative review of the topic, including how people learn informally online, how organizations can best design for informal online learning, and how outcomes of tacit and intentional informal online learning can be credibly and feasibly evaluated to elevate the field and improve the funding opportunities for informal online outreach education.

Conclusion

In a time and country where the Internet and mobile devices abound, tacit and intentional learning happens informally online all the time. Yet, existing literature does not adequately address the Internet as a space for learning outside course structures. It is important to conceptualize and design public websites pedagogically, and re-imagine outreach education (Sandlin et al., 2010). Scientific organizations that work to inform and educate the public outside of traditional education settings will need to understand how the Internet is used to learn, through both self-directed and incidental learning. Our democracy relies on informed citizens. Therefore, this dissertation has aimed to share online educational design strategies and methods that have been used to measure learning and behavior change outcomes resulting from such design. It is also important to note

that the study found effectively employing the aforementioned design strategies and evaluation will require collaboration among subject matter experts, multi-media creators, web developers, and more. This kind of cross-organization collaboration requires a common vision and vocabulary. Therefore, this study has not only shared design examples across the spectrum of Anderson's (2008) informal learning environment variables, but also provide a common language and goals to frame the interdisciplinary collaboration necessary to employ them.

Summary

This chapter discussed the study's conclusions, beginning with implications for practice. It also completed the quantitative ethnographic analysis by sharing collective ENA diagrams comparing the networks of the Field Museum and NOAA's theoretical perspectives, evaluation strategies, and research foci as shared in the interviews. As such, it described the emerging state of the discipline. Unanticipated conclusions and limitations were acknowledged. Lastly, I discussed recommendations for future research and the ways in which I have shared and will communicate the outcomes of this study.

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APPENDIX A

Research Webpage

Alison Anderson Holland

Instructional Design | Outreach Strategy

ABOUT CURRENT RESEARCH CV WORKING TOGETHER

Decoding a New Age of Informal Learning

Defining Public Pedagogy for the Web

As you are well-aware, informal learning has drastically changed in the past two decades as information and interaction online has grown and evolved. Much informal learning today occurs online, but many non-profit and governmental institutions do not yet understand and effectively utilize the new ecosystem in their outreach. Therefore, this study aims to provide a model for educational design and evaluation in the present online environment.

I have chosen a collective case study methodology to illustrate effective design of informal online learning and related evaluation methods that can be employed. After completing a scan of the internet for potential cases to study, I identified websites that can serve as strong examples of websites of effective informal online learning design. I am currently reaching out to these sites to secure interviews about the design and evaluation strategies they utilize and how they came to these selections.

If you have any questions regarding this study, please contact me at aanderson28@hamline.edu.

I hope that the results of my study will be of benefit to those organizations directly involved in the study, other outreach education organizations not directly involved in the study, as well as to the broader informal online learning research community.

APPENDIX B

Letter of Informed Consent for Interview

Month ##, 2018

Dear FirstName LastName,

This letter is an invitation to consider participating in a study I am conducting as a doctoral Candidate in Hamline University's School of Education under the supervision of Trish Harvey. I would like to provide you with more information about this project and what your involvement would entail if you decide to take part.

As you are well-aware, informal learning has drastically changed in the past two decades as information and interaction online has grown and evolved. Much informal learning today occurs online, but legacy nonprofit and governmental institutions have largely not understood nor capitalized on the new ecosystem. Therefore, this study aims to provide a model for educational design and evaluation in the present online environment.

I have chosen a collective case study methodology to illustrate effective design of informal online learning and related evaluation methods that can be employed. After completing a scan of the Internet for potential cases to study, I identified your organization's outreach website as a strong example of effective informal online learning design. I would be grateful for the opportunity to interview you about the design and evaluation strategies you have utilized with (insert web address) and how you came to these selections.

Participation in this study is voluntary. It will involve an interview of approximately thirty minutes in length to take place at a mutually agreed upon time through an online medium (e.g., Google Hangouts, WebEx). The interview questions are open-ended. You may decline to answer any of the interview questions if you so wish. Further, you may decide to withdraw from this study at any time without any negative consequences by advising the researcher. With your permission, the interview will be digitally audio-recorded to facilitate collection of information, and later transcribed for analysis. Shortly after the interview has been completed, I will send you a copy of the transcript to give you an opportunity to confirm the accuracy of our conversation and to add or clarify any points that you wish.

Given the selection of cases with public funding, and with a topic that is not of a personal nature, the information you provide would not be confidential, but will be used for the limited purpose of illustrating design and evaluation strategies for informal online learning. Data collected during this study will be retained for one year in encrypted online storage. Only researchers associated with this project will have access. There are no known or anticipated risks to you as a participant in this study.

If you have any questions regarding this study, or would like additional information to assist you in reaching a decision about participation, please contact me at (612) XXX-XXXX or by e-mail at XXXXX@hamline.edu. You can also contact my supervisor, Trish Harvey at 651-523-2532 or tharvey03@hamline.edu.

I would like to assure you that this study has been reviewed and received ethics clearance through the Institutional Review Board (IRB) at Hamline University. However, the final decision about participation is yours. If you have any comments or concerns resulting from your participation in this study, please contact the chair of the IRB (Matthew Olson, 651-523-2430,

mholson@hamline.edu).

I hope that the results of my study will be of benefit to those organizations directly involved in the study, other outreach education organizations not directly involved in the study, as well as to the broader informal online learning research community.

I very much look forward to speaking with you and thank you in advance for your assistance in this project.

Sincerely,

Alison S. A. Holland
XXXXX@hamline.edu

APPENDIX C

Informed Consent to Participate in Qualitative Interview

I have read the information presented in the information letter about a study being conducted by Alison S. A. Holland, a doctoral student in the School of Education at Hamline University. I have had the opportunity to ask any questions related to this study, to receive satisfactory answers to my questions, and any additional details I wanted.

I am aware that I have the option of allowing my interview to be digitally audio-recorded to ensure an accurate recording of my responses.

I am also aware that excerpts from the interview may be included in the dissertation and/or publications to come from this research.

I was informed that I may withdraw my consent at any time without penalty by advising the researcher.

This project had been reviewed by, and received ethics clearance through, the Institutional Review Board at Hamline University. I was informed that if I have any comments or concerns resulting from my participation in his study, I may contact the Chair of the Institutional Review Board at 651-523-2430 or mholson@hamline.edu.

With full knowledge of all foregoing, I agree, of my own free will, to participate in this study.
____ YES ___ NO

I agree to have my interview digitally audio-recorded.
____ YES ___ NO

I agree to the use of quotations in any dissertation or publication that comes of this research.
____ YES ___ NO

Participant's Name (please print) _____

Participant's Signature _____ Date _____

Researcher's Signature _____ Date _____

Researcher's Title _____ Department _____

Faculty Advisor Signature _____ Date _____

Faculty Advisor Title_____Department _____

APPENDIX D

IRB Approval Letter

HAMLINE UNIVERSITY

TO: ALISON ANDERSON HOLLAND

FROM: HAMLINE UNIVERSITY INSTITUTIONAL REVIEW BOARD (IRB)
(06/29/2018)

RE: IRB APPROVAL
Your proposal entitled "DECODING A NEW AGE OF INFORMAL LEARNING: DEFINING PUBLIC PEDAGOGY FOR THE WEB" is exempt from review and therefore approved.

Thank you for registering with the IRB.

Good Luck with your project.

www.hamline.edu 1536 Hewitt Avenue, Saint Paul, MN 55104-1284 p: 651-523-2800

APPENDIX E

Websites Considered

***Award-Winning Nonprofit Websites**

1. acumen.org
2. adoptalovestory.com
3. care.org
4. casefoundation.org
5. charitywater.org
6. conservation.org
7. convyofhope.org
8. davidshepherd.org
9. gatesfoundation.org
10. greenpeace.org/usa
11. invisiblechildren.com
12. nashvillezoo.org
13. aqua.org
14. roomtoread.org
15. rotary.org
16. savethestorks.com
17. teachforamerica.org
18. valleyymca.org
19. worldwildlife.org
20. pawsatlanta.org
21. hrw.org
22. energyupgradeca.org

*Sampling found on topnonprofits.com and webaward.org (Top Nonprofits, 2017; Web Awards 2018, n.d.).

Museum Websites

1. si.edu
2. smm.org
3. fieldmuseum.org
4. cosi.org
5. mos.org
6. exploratorium.edu
7. californiasciencecenter.org
8. museumofdiscovery.org
9. lanl.gov/museum
10. calacademy.org
11. msichicago.org
12. ansp.org

Government Agencies

1. nasa.gov
2. noaa.gov
3. usda.gov
4. fda.gov
5. cdc.gov
6. foodsafety.gov

APPENDIX F

Interview Guide

Pre-Interview Script:

As you are well-aware, informal learning has drastically changed in the past two decades as information and interaction online has grown and evolved. As such, this study aims to provide a model for educational design and evaluation in the present online environment.

I have chosen a collective case study methodology to illustrate effective design of informal online learning and related evaluation methods that can be employed. After completing a scan of the Internet for potential cases to study, I identified your organization's outreach website as a strong example of effective informal online learning design. The following interview questions will be around the design and evaluation strategies you and your colleagues have utilized with (insert web address) and how you came to these selections.

1. Please begin by sharing with me about how your site and its content came to be.
    a. How did the website and other online presences (e.g., social media sites) of your organization start and/or go through a redesign?
        - Who was involved (i.e., types of positions)?
    b. Did existing educational programming play a role in this process? Explain.
    c. Why is this an online resource rather than an in-person program?
        - How does it differ from face to face programs?
        - What were the challenges you were facing and/or the benefits you were seeking?
    d. How did the design and content get developed?

In the next question I want to get at who plays roles in designing, developing, and sharing your online content, and who might interact in other ways related to learning.

2. How do you think about the role of the "expert" (i.e., content creator, educator, moderator, or writer) and the "learner" (i.e., online audience member or visitor) on your website?
    a. What experiences have brought you to these views?
3. Do you evaluate or measure the impact of your site and its content?
    a. If not, why not? What would you measure if it were feasible?
    b. If yes:
        What do you look to understand and/or what is the impact you want to measure?
            1. Has this changed or evolved over time?
            2. What have you learned?
        What methodology do you find most useful when conducting this research?
            3. Do you use any formal methods to validate your findings?
            4. Has your approach to evaluation changed over time?
            5. What else would you do, if it were feasible?
4. What is your biggest challenge in the design or evaluation of your site?
5. What are the unanticipated benefits you have found from this work?
6. Demographics
    a. Position
    b. Education level
    c. Years of experience in the field
    d. Other relevant experience
7. Overall organization budget

APPENDIX G

Field Notes Format

					Date/time (original date if indicated by source; otherwise indicated collection date)
					Unit (Organizations)
					Resource Type (Conversation)
					Source
					Raw data
					Summary/Qualitiative Example
					TP.IV.Independent
					TP.IV.Structured
					TP.IV.Community
					TP.IV.Paced
					ES.Survey
					ES.TextAnalysis
					ES.Interviews
					ES.Observation
					ES.Analytics
					ES.NetworkAnalysis
					ES.FoocusGroup
					ES.PrePostTests
					RF.UserCount
					RF.ContentAppraisal
					RF.StageOfChange
					RF.REAIM
					RF.TimeSpent
					RF.LearningOutcomes
					RF.Enjoyment

APPENDIX H

Epistemic Network Analysis Theory

The following description of ENA theory is adapted from the language provided by the ENA0.1.0 Web Tool.

Epistemic network analysis (ENA) is a quantitative ethnographic technique for modeling the structure of connections in data. ENA assumes (a) it is possible to systematically identify a set of meaningful features in the data (codes); (b) data has local structure (conversations); and (c) an important feature of the data is the way that codes are connected to one another within conversations (Shaffer, 2017; Shaffer, Collier, & Ruis, 2016; Shaffer & Ruis, 2017). For example, if a team is working on a design project, they talk about important codes, such as production processes, design specifications, budget, and so on. They have a series of conversations at design meetings, and a key part of understanding their design process is modeling how they think about the relationships between production processes, specifications, budget, and other key parts of their design work (Arastoopour, Shaffer, Swiecki, Ruis, & Chesler, 2016). ENA models the connections between codes by quantifying the co-occurrence of codes within conversations, producing a weighted network of co-occurrences, along with associated visualizations for each unit of analysis in the data. Critically, ENA analyzes all of the networks simultaneously, resulting in a set of networks that can be compared both visually and statistically.

ENA was originally developed to model theories of cognition, discourse, and culture that argue that the connections people make in discourse are a critical level of analysis (Shaffer et al., 2009). DiSessa (1988), for example, characterized learning as a process by which isolated elements of experiential knowledge are connected through

theoretical frameworks to develop both new knowledge and deep, systematic understanding. Similarly, Linn, Eylon, and Davis (2004) argued that learners develop STEM expertise by constructing a knowledge web: a repertoire of ideas and the connections among them. Shaffer (2006, 2007, 2012) characterized learning as the development of an epistemic frame: a pattern of connections among knowledge, skills, habits of mind, and other cognitive elements that characterize communities of practice (Hutchins, 1995; Shaffer, 2004; Wenger, 1999) or groups of people who share similar ways of framing, investigating, and solving complex problems.

While ENA was originally designed to address challenges in learning analytics, the method is not limited to analyses of learning data. For example, ENA has been used to analyze (a) surgery trainees' operative performance during a simulated procedure (Ruis et al., in press), (b) gaze coordination during collaborative work (Andrist, Collier, Gleicher, Mutlu, & Shaffer, 2015), and (c) communication among healthcare teams (Sullivan et al., 2017; Wooldridge, Carayon, Eagan, & Shaffer, 2018). The key assumption of the method is that the structure of connections in the data is the most important in the analysis. In other words, ENA is an appropriate technique for any context in which the structure of connections is meaningful. ENA is thus a useful technique for modeling an emerging disciplinary matrix because it can model the relationships among theoretical perspectives, evaluation strategies, and research foci as they occur within interview conversations with practitioners in the field.

ENA Methods

In this study, I applied ENA (Shaffer, 2017; Shaffer et al., 2016; Shaffer & Ruis, 2017) to my data using the ENA0.1.0 (Marquart, Hinojosa, Swiecki, & Shaffer, 2018) Web Tool (version 0.1.0; Marquart et al., 2018). I defined the units of analysis as all lines

of data associated with a single utterance subsetted by organization studied. For example, one unit consisted of all the lines associated with the Field Museum.

The ENA algorithm uses a moving window to construct a network model for each line in the data, showing how codes in the current line are connected to codes that occur within the recent temporal context (Siebert-Evenstone et al., 2017); the resulting networks are aggregated for all lines for each unit of analysis in the model. However, in this study utterances were only reviewed for co-occurrence of codes within a given utterance. The decision to not enable the ENA algorithm to review connections among consecutive utterances was due to the nature of interviews being researcher-driven rather than a typical conversation. Therefore, in this model, I aggregated networks using a binary summation in which the networks for a given line reflect the presence or absence of the co-occurrence of each pair of codes.

My ENA model included the following codes: ES.Survey, ES.TextAnalysis, ES.Interviews, ES.Observation, ES.Analytics, ES.NetworkAnalysis, ES.FoocusGroup, ES.PrePostTests, RF.UserCount, RF.ContentAppraisal, RF.StageOfChange, RF.REAIM, RF.TimeSpent, RF.LearningOutcomes and RF.Enjoyment. I defined conversations as all lines of data associated with a single value of resource type, such as interview responses or Twitter feed observations. To ensure consistency, the ENA used in this study only included the interview responses, not the netnographic observations.

The ENA model normalized the networks for all units of analysis before they were subjected to a dimensional reduction, which accounts for the fact that different units of analysis may have different amounts of coded lines in the data. For the dimensional reduction, I used a means rotation based on two groups in my data: FieldMuseum and NOAA. This projection highlights the differences between these groups (if any) by

constructing a dimensional reduction that places the means of the groups as close as possible to the x-axis of the projected space. Subsequent dimensions were projected using singular value decomposition, which produces orthogonal dimensions that maximize the variance explained by each dimension. (See Shaffer et al., 2016 for a more detailed explanation of the mathematics; see Arastoopour, Swiecki, Chesler, & Shaffer, 2015 and Sullivan et al., 2017 for examples of this kind of analysis.)

Networks were visualized using network graphs where nodes correspond to the codes and lines reflect the relative frequency of co-occurrence, or connection, between two codes. The result is two coordinated representations for each unit of analysis: (a) a plotted point, which represents the location of that unit's network in the low-dimensional projected space, and (b) a weighted network graph. The positions of the network graph nodes are fixed, and those positions are determined by an optimization routine that minimizes the difference between the plotted points and their corresponding network centroids. Because of this co-registration of network graphs and projected space, the positions of the network graph nodes—and the connections they define—can be used to interpret the dimensions of the projected space and explain the positions of plotted points.

ENA can be used to compare units of analysis in terms of their plotted point positions, individual networks, mean plotted point positions, and mean networks, which average the connection weights across individual networks. Networks may also be compared using network difference graphs. These graphs are calculated by subtracting the weight of each connection in one network from the corresponding connections in another. To test for differences the ENA tool applied a two-sample *t* test assuming unequal variance to the location of points in the projected ENA space for units in FieldMuseum and NOAA.

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