

Learning and the Practice of Social Media in Informal Science Education Centers

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Abstract

Both social media and informal learning spaces have the potential to foment knowledge-building. This article aims to bridge theory and practice with an analysis of the social media practices across informal science learning centers through the lens of the Contextual Model of Learning. We evaluate strategies through directed content analysis of phone interviews, online surveys, and researcher field notes. Our findings reveal that informal science learning centers create marketing-related social media strategies as opposed to ones which align with contemporary learning in informal settings. Implications for researchers who seek to use social media in an educative manner are discussed.

Keywords

Social media, informal education, museum education, qualitative analysis, science museums

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Introduction

Social media is a term used to describe Internet-based applications where users develop a profile, connect with others, and use these connections in whatever ways they see fit (boyd & Ellison, 2007). These connections form the foundation of relationships that can be built between people, between organizations, or between people and organizations. Informal learning settings, such as museums and science centers, also seek to form these relationships with visitors by

establishing learning environments where people interact with one another in the setting and interact with the setting itself. Similarly, social media allows users to explore their varied interests through connections to virtual objects and connections with other users. In both environments, people seek to learn about the world through connections that serve to mediate the learning process. However, recognition and accounting for social media as a vehicle for learning within informal science settings is an area that is under-researched and particularly under theorized.

To extend our understanding of the potential for social media to be used synergistically with informal science education, this study involved an analysis of the social media practices across a diverse collection of informal science learning centers through the lens of Falk & Dierking's (2013) Contextual Model of Learning (CMoL), a contemporary theoretical framework based upon learning in informal settings. With an attempt to bridge current practice with theory, we sought to address the following research question: *What social media strategies are being used by informal science learning centers in the United States and how are these strategies related to our current understanding of learning in informal settings?*

We begin by reviewing the existing research related to the use of social media as it pertains to informal science education and detail the CMoL as the theoretical framework for this study. We then provide a description of the sampling and data collection methods, including directed content analysis of an existing data set of phone interviews and online surveys describing social media plans from members of an association of informal science education centers. To understand how these centers' social media plans aligned with the CMoL, coding categories were built and used for directed content analysis of their social media plans. Lastly, findings

concerning the attributes of the social media plans are discussed. We conclude by examining the implication for informal science learning centers seeking to education the public and engage their visitors in learning via social media as well as discuss implications for the field of social media research.

Literature Review

Since the inception of the World Wide Web, networked communication has exploded, fomenting participatory and collaborative connections world-wide on social media platforms such as Wikipedia (2001), Facebook (2004), Twitter (2006), and Instagram (2010) (Kaplan & Haenlein, 2010; van Dijck, 2013). Research has shown that scientists participate in social media to gain academic connections, to self-promote, or to simply keep up with the field (Bowman et al., 2015; Van Eperen & Marincola, 2011; Van Noorden, 2014). However, scientists also use social media to build citizen science efforts, contribute to social learning, and educate the public about the natural world (Daume & Galaz, 2016; Kimmerle, Moskaliuk, Oeberst, & Cress, 2015; Racaniello, 2010). Many, if not most efforts by scientists to communicate with the public are outreach-focused and dissemination-based, suggesting that scientists, whether they are interested in formal or informal educative efforts, are not involved with meaningful education-based conversations with their social media followers (Fauville, Dupont, Thun, & Lundin, 2015; Lee & VanDyke, 2015). For informal science settings, social media is often relegated to the marketing department as a form of word-of-mouth advertising—one of the most common drivers for membership and visitorship for museums (Hausmann, 2012). However, Baker's (2014) study of 27 science museums' Twitter interactions revealed that conversational and educational museum tweets received more retweets, replies, and favorites versus tweets that had a marketing focus.

Based on findings by Baker (2014), Fauville et al. (2015), and Lee and VanDyke (2015), developing educative, communicative, and content-focused messaging is a social media best practice. Such practice can allow for better user engagement in the form of conversations on social media between those who manage informal science settings and those who they seek to educate and communicate with. However, missing from these studies is a connection to a contemporary perspective for designing visitor experiences in settings that focus on informal science, such as museums or science centers. We contend that such a connection would afford a meaningful expansion and further ground the mission for these learning institutions across all forms of media that are used for engaging the public.

Theoretical Framework

The CMoL contends that learning in an informal setting involves three distinct and interrelated elements: the *sociocultural context*—an amalgam of each person’s language, beliefs, customs, and ways of knowing with complimentary constructs that are distinct to the setting being visited; the *personal context*—encompassing each person’s knowledge and life experiences; and the *physical context*—the physical setting that each person experiences through their free-choice (Falk & Dierking, 2013). These elements are viewed as a dynamic system that changes over the course of time within a person’s lifespan. The CMoL encompasses over twenty years of empirical work at cosmopolitan informal science learning centers and as a theoretical framework, it presents a robust and empirically grounded means for describing learning across a broad range of informal learning venues. As such, it has the potential of grounding and informing the current social media practices that are used by professionals in informal learning settings. This study represents a first attempt at realizing this potential.

The sociocultural context of CMoL recognizes that group dynamics affect learners in informal settings. Informal science learning centers provide a backdrop for visitors to explore records of scientific and social accomplishments and as such offer unique opportunities for visitors to interact with each other as much as with the information (Leinhardt, 2000). Visitors communicate with one another while in informal environments, sometimes using inquiry-based skills to explore scientific concepts, including biology and evolution (Ash, 2003; Gutwill & Allen, 2009). Families visiting with young children use different communication strategies and styles than adult visitors, yet in all situations the group dynamic affects the learning that takes place (Diamond, Smith, & Bond, 1988; Dierking & Falk, 1994; Leinhardt, Crowley, & Knutson, 2002). Not all people communicate on their visits in the same way, which is unsurprising given that people visit informal science settings for various reasons.

While the sociocultural context of CMoL emphasizes how people learn together, the personal context explains visitors' individualistic inclinations regarding learning in informal science settings. Falk and Storksdieck (2010) describe five key categories of visitor motivations: explorers, facilitators, hobbyists, experience seekers, and spiritual pilgrims. Furthermore, visitors' motivations and reasons to learn in informal environments are based upon interest, prior experience, and prior knowledge (Falk, 2006; Falk, Heimlich, & Bronnenkant, 2008; Falk, Moussouri, & Coulson, 1998). Prior knowledge and interest can develop from oral communication (i.e. word of mouth) in which trusted sources provide a potential visitor with reasons to visit a setting, although the potential visitor must also be self-motivated to visit. Regardless, oral communication is a component of motivating people to visit and learn in informal settings. Falk and Dierking (2013) postulate that social media acts as a scaled-up form

of word of mouth marketing (a common phrase for this form of oral communication), as users can broadcast their personal context for visiting an informal science setting to anyone. While oral communication is key to disseminating information, social media can be used for much more, including educative practices.

Finally, the physical context of CMoL accounts for how learners (i.e. visitors) perceive the physical space of a setting. In terms of informal science, this includes the layout of exhibits or the architecture of the building itself. Exhibit layouts can dictate “holding time,” or the length of time a visitor remains in an exhibit (Serrell, 1997); timing and tracking of visitor patterns reveals how visitors use certain types of exhibits (Yalowitz & Bronnenkant, 2009); and label text on exhibits can entice or repel visitors (Nesbitt & Maldonado, 2016). Furthermore, empirical research has shown that patterns exist depending on the visitor type: first time and less experienced visitors explore the museum in a disoriented manner, experienced visitors selectively explore the museum methodically, and organized groups are often guided through the museum by docents (Diamond, 1986; Falk, 1991; Falk, Koran, Dierking, & Dreblow, 2010). Within the museum, navigating the museum via signage, labeling, and maps can present challenges to inexperienced visitors (Bitgood, 2006). Outside of the museum itself, the physical context can also encompass the act of getting to the museum, including hassles with parking or public transportation options. These aspects of the physical context are especially important for visitors who are inexperienced with informal science settings, who can be prone to “museum fatigue” and who are unfamiliar with museum maps (Bitgood, 2009; Hayward & Brydon-Miller, 1983). The entire physical context can hinder or help learners as they interact with it.

Though the CMoL has yet to fully account for social media practices, the diversity of data

that has been used to build the theory suggests that it is a keystone to the way that many, if not most, informal science educators view learning in informal science settings. Utilizing the CMoL's three contexts for learning provides a solid empirical and contemporary base for understanding social media use in informal science learning centers. Furthermore, aligning social media use with the CMoL will serve to situate this new work within the existing field and ensure that other researchers recognize the value of social media strategies that are driven by learning theories.

Research Question, Sampling, & Data Collection

The purpose of this study was to use the CMoL to examine how a collection of informal science learning centers from across the U.S. approached the use of social media in relation to their function as informal science learning centers. An exploratory single case study methodology (Merriam, 2009) was used to address the following research questions: *What social media strategies are being used by informal science learning centers in the United States and how are these strategies related to our current understanding of learning in informal settings?* The case was bounded by our intent to understand the approach to social media being used by a collection of recognizable venues for public engagement in the process of informal science education. Representatives responded on behalf of their employer indicating current policy and/or practice. Therefore, the informal science learning centers served as our case participants. The limited research relating use of social media and learning in informal educational contexts dictated our context-dependent method and deductive form of data analysis based upon the CMoL.

Sampling and Data Sources

Based upon our case criteria, a detailed sampling strategy was developed and used for recruiting participants from the affiliates of the Association of Science and Technology Centers (ASTC). ASTC is one of the two largest and well-known consortiums of museums in the U. S. and the only one that focuses explicitly on science, and as such, member institutions subscribe to fundamental principles which seek to develop public understanding of science. ASTC affiliates serve to educate and facilitate discourse about science topics and affirm such principles through their mission statements, practices, and services. ASTC affiliates are defined as science centers, museums, or related institutions that inspire lifelong science learning, therefore, we refer to them as informal science learning centers (i.e. centers) (ASTC, 2016).

A database of potential participants was created from the list of centers on ASTC's online database (N= 326). Using publicly available information found by searching the web for the name of the center, the following metadata were added for each: geographic location, website URL, contact information for museum staff, social media site(s) URLs, and number of followers on social media site(s).

The potential participant pool was reduced by excluding children's museums and centers without social media sites, leaving only centers that catered to learners of all ages. Children's museums were excluded because they focus on the needs of young children versus the needs of the whole family or learners in general (Silav, 2014). The sampling size was further restricted by the number of centers that did not provide explicit contact information on their websites. If a center did not have a contact person listed, that center was excluded. In total, representatives from 209 centers were contacted as potential participants.

Respondents from 18 centers answered our initial inquiry, met our inclusion criteria of

either providing a written social media plan or agreeing to be interviewed about the center's social media practices. Of the 18 respondents, five included the center's social media plan as an attachment or copied it into their email response. The respondents who were subsequently interviewed via telephone indicated that their center's social media plan was not written per se, but discussed ways in which they used social media and in some cases, aligned it to their center's mission. A brief description of the centers who participated is provided with pseudonyms for center names, generalized numerical values for their social media followers, a description of their general location, and an indication of their style of social media implementation (Table 1).

Table 1
Informal science education centers included in data analysis

De-identified center	Generalized location in the U.S.	Approximate number of Facebook likers	Approximate number of Twitter followers	Written social media plan
Center-1	West	800	100	
Center-2	Northwest	12000	10000	X
Center-3	East	1500	4000	
Center-4	Midwest	11000	250	
Center-5	Northeast	7500	4350	X
Center-6	West	3000	150	
Center-7	West	3500	NA	
Center-8	West	2000	20	
Center-9	East	35500	2500	
Center-10	Midwest	3500	300	
Center-11	Northeast	4000	1650	
Center-12	Northeast	7000	192000	X
Center-13	West	11500	1000	X
Center-14	Northeast	18000	12700	
Center-15	Midwest	30000	9300	
Center-16	East	21000	19000	
Center-17	Northwest	2000	NA	
Center-18	West	48000	12000	X

To address our research question and explore how the CMoL accounts for social media practice in informal science education, the data collection techniques of telephone interviews and modified online surveys were used (see supplemental documents). These data complimented the

social media plans and ensured that the voices of those intimately involved with the process of creating and using social media in these informal settings were heard (Merriam, 2009).

Regardless of contact method, respondents answered similarly-worded questions concerning descriptions of how their social media aligned with the mission of their center, how social media plans were aligned with learning, and descriptions of types of posts the center made on specific social media networks.

Data Analysis

Data analysis involved directed content analysis (Hsieh & Shannon, 2005), which was applied to the social media plans, responses to online survey questions, and researcher field notes. In this deductive form of qualitative analysis, high-level coding categories were created based upon the three elements of the CMoL. Distinct coding categories were further delineated using operational definitions and open-ended questions. Low-level codes nested within the coding categories included in vivo codes, which were applied when participant language adeptly described coded segments and structural codes, which focused on the content of the coded segments (Saldaña, 2013). Coding categories and their respective codes were then refined and revised through a recursive process. For example, coding for the CMoL involved looking for responses that incorporated the concepts of visitor motivations (Sociocultural Context), individual interests (Personal Context), and familiarizing the visitor with the museum space (Physical Context). Additional axial coding categories, including the implementation of social media without pre-conceived thought (“Ad hoc”) and social media use for marketing purposes (Knowledge Sharing) were created when the original three coding categories of the CMoL did not account for all responses (Table 2).

Table 2
Directed content analysis codes

Coding category and source	Operational definitions & Open-ended questions	Codes	Data exemplar
Knowledge Sharing (Axial Code)	Social media use for marketing first, viewing social media users only as customers instead of learners How do institutions develop social for marketing? In what ways is the concept of dissemination discussed? How do they respondents describe being a resource?	Social word of mouth, dissemination, outreach-based, exhibit-focused, public relations (PR), embedded in marketing plan, driver of customer service inquiries, money for dissemination, conversion to visitors, STEM resource	“We focus our marketing and communications on events and exhibits, and we use Facebook as part of our overall communication plans for those events and exhibits.” (Center-7)
Personal Context (CMoL)	Each person’s knowledge and life experiences In what ways are visitor identities accounted for?	Accessibility of science, content, or institution, developing personal interest in science, knowledge of audience, educational content, drawing new audiences, intersection of interests	Social media “is a way that people can choose their own engagement; gives people an option, the audience chooses what they want to engage in.” (Center-8)
Ad hoc (Axial Code)	Indicating that social media is done without pre-conceived thought In what ways do respondents describe social media use that is unstructured?	We just do it, budgetary constraint, ad hoc, guilty ad hoc, constant monitoring/stress, no formal plan, organic, no goal	“We never set a goal. We just keep trying to do what works and stop doing what did not work.” (Center-10)
Sociocultural Context (CMoL)	Amalgam of each person’s language, beliefs, customs and ways of knowing with complimentary constructs that are distinct to the setting being visited How do institutions understand the relationships visitors have? How do institutions define their relationships with their visitors?	Engage on social, constituents, ‘facilitator’ interests, demographic description of audiences, real people follow us	“Many women in this group are parents who view [Center-18] as an educational and recreational resource for their children. For this reason, we post several times a week on activities of interest to moms and children” (Center-18)

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Physical Context (CMoL)	The physical setting that each person experiences through their free-choice How do learners perceive the physical space of the museum? How are efforts made to familiarize visitors with the space?	behind-the-scenes, exhibit content	“When we have traveling exhibits, I regularly post about things related to the exhibit” (Center-4)
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Directed content analysis is not without its limitation, including the potential for researcher bias in the form of explicitly searching for content related to the codes and either forcing the data into the selected codes (i.e. false positive) or excluding passages that do not align (i.e. false negative). Researcher bias was mitigated through coding to consensus with a research team, carefully assessing the data multiple times, and employing a process of continuous reflection for the coding categories, codes, and their use. Furthermore, data was collected in multiple forms (i.e. online surveys, telephone interviews, researcher field notes) and a constant comparative method of analysis was used across these forms.

All responses were coded in HyperResearch software and then examined for frequencies. We present the results from each coding category, focusing on the most salient codes, using examples from multiple respondents across the case to illustrate results. The order of presentation is based upon Gibbs' (2007) recommendation, organizing codes from most frequently represented to least frequently represented in our data sources. Quotations include a citation to the respondent and data source. We found that coded segments most often described centers' social media in marketing terms (Knowledge Sharing) (n=24), followed by the Personal Context from CMoL (n=18), which involved a focus on using social media to meet audiences' individual interests. Nineteen percent of coded segments concerned conducting social media work without any structured plan (Ad hoc) (n=14). Two elements of the CMoL, the Sociocultural Context (n=10) and the Physical Context (n=5), were far less represented than the element of the

Personal Context.

Knowledge Sharing. To develop content and reach a variety of audiences, many respondents detailed the intersection of their center's social media and marketing plans, which we recognized with an axial coding category called *Knowledge Sharing*. Knowledge Sharing was the most frequently coded coding category, comprising 34% of all coded segments (n=24). This category featured responses concerning the dissemination of content to audiences, a focus on highlighting social media's place within the center's marketing plan, and a conversion of followers to physical visitors.

Dissemination of exhibition-focused or event-focused content on social media was a prevalent concern of many centers. Some of the respondents spoke to the capacity social media gives them for driving messages to their center's audience, including Center-12, whose social media plan was often used to "disseminate information about exhibitions, programs, and collections" (survey) and Center-8, whose social media was often used as "awareness messaging, letting people know about events" (interview). Others viewed social media as a way for "patrons" to discover events through social media "posts and shares" (Center-10, survey). New exhibits and initiatives also led to increased dissemination of social media content, as indicated by Center-15, whose respondent wrote, "I write more formal social media plans when we have a new IMAX film, exhibit or initiative" (survey). The emphasis on using social media to disseminate information on events and exhibits seems to be closely related to the idea of a social media plan that is wedded or closely aligned with the center's marketing plan.

Social media was explicitly viewed as a marketing tool by a number of centers. The connection between information dissemination and marketing is elucidated in the online survey

response for Center-7: “we use Facebook as part of our overall communication plans for events and exhibits.” Center-18 also interpreted social media as a marketing tool, “social media channels serve as an integral part of public relations and marketing efforts” (plan). These respondents all indicate a focus on using social media platforms, such as Facebook, to enhance marketing initiatives, a concept that is unrelated to the CMoL.

The dissemination of exhibition or event information and a focus on marketing often coincided with the third concentration in this coding category, the conversion of social media followers to center visitors. The emphasis on conversion was highlighted in the respondent from Center-6 who wrote “better yet, [a social media follower] goes to our website and signs up for a class” (survey). The respondent from Center-18 echoed this sentiment, writing that they “leverage social media to drive attendance at activities and events, thus supporting [the institution’s] revenue generation” (plan). The respondent from Center-17 casually exclaimed in their online survey, “Our goals with social media is *of course* to drive people to our facility” (emphasis added). While this respondent did not explicitly indicate that their center viewed social media as a marketing tool, the respondent valued converting social media followers to visitors, a common theme in the social media strategies.

Personal Context. The Personal Context of CMoL postulates that each person’s life experiences, knowledge, and motivations can influence their experiences in an informal setting. The coding category *Personal Context* exhibited the second-highest frequency of segments, comprising 25% (n=18) of all coded segments. Within this category, responses included an emphasis on a center’s knowledge of their visitors as well as a focus on visitor interest in and accessibility of content. These codes conveyed Personal Context in that respondents attempted to

reach and enhance individual visitor experiences through using social media to cater to individuals' interests.

We found evidence for Personal Context relating to the way that social media is implemented when respondents described their intimate knowledge of visitors. Even though respondents had a marketing-centric ideology, referring to visitors as “audiences,” they describe implementing social media in a way that aligns with the Personal Context of CMoL, to meet visitor knowledge and motivations. Respondents described tailoring “content to create more relevant postings” based on their visitors’ needs, using platforms they “know [their] core audience uses” (Center-13, plan) and developing social media for specific visitors, such as the “young, hipper crowd” (Center-18, plan). Intimate knowledge of their visitors also allowed respondents to develop social media based on individual motivations because “[social media] is a way that people can choose their own engagement: it gives people an option, the audience chooses what they want to engage in” (Center-8, interview). Through these responses, respondents show that they acknowledge the unique perspectives that visitors bring when interacting with centers and they know how to respond to these unique perspectives.

Coded responses for Personal Context also focused on visitor interest. For this case, visitor interest covered a wide range from entertainment to education. Representing an education-focus, respondents indicated that their social media: concentrated on “engaging with [visitors] on educational content” (Center-18, plan); supplied information related to “science and technology and [institution]” (Center-12, survey); and was “a place for the audience to view science concepts” (Center-8, interview). Another respondent wrote that visitors were interested in research and therefore, the point of their social media was “to communicate about research”

being done at the institution (Center-2, plan). Embodying a balanced perspective, respondents suggested that visitors “have an interest in education, fun and the need to be entertained” (Center-14, survey) and want to see science-related content that is entertaining, such as “kids science activities, holiday science activities, outdoor science activities, outdoor gardening activities” (Center-4, survey) while another sought to describe the inherent excitement of science, writing “we try to point out the science in everyday life—whether we post photos of our latest exhibit or a youtube [*sic*] video of an at-home experiment, we recognize that science is fun” (Center-6, survey). In this category, codes revealed that respondents sought to motivate their visitors through being accessible as well as through aligning with their visitors’ interests.

Ad hoc. *Ad hoc* is an in vivo coding category which took its name from the language a respondent used to describe their lack of pre-conceived thought as a method for social media implementation. Twenty percent of all codes were grouped into this coding category (n= 14). The main ideas included a general sense of implementing social media without a plan, indicating budgetary or staffing constraints which prevented participants from implementing social media in an orderly fashion, and feeling guilty that social media was implemented without forethought.

Many instances within the Ad hoc category featured unplanned usage of social media. Erratic social media strategies, which were frequently touted as unscheduled or unmapped, were used across centers, whose respondents wrote or said, “I don’t usually have a specific schedule for my day-to-day posts” (Center-15, survey); “[Staff] communicate with each other about what and when we create posts, but there is no formal plan” (Center-17, survey) and “we make it up as we go along, we don’t map it on a calendar” (Center-3, interview). Respondent quotes further illustrate unstructured use, including, “we don’t have any specific goals [for our social media],

we just do it” (Center-17, survey); “we never set a goal. We just keep trying to do what works and stop doing what did not work” (Center-10, survey); and “I do not have a formal social media plan per se” (Center-4, survey). Interestingly, consistent social media use via one staff member being assigned to social media also coincided with the indication that budgetary restrictions were the reason for such methods.

A number of respondents indicated that tightened budgets and staffing limitations restricted them from implementing social media in more ambitious ways. The respondent from Center-10, who indicated that using one staff person kept social media consistent, also wrote that their social media was “organic...given that we have such a very small staff and limited, dynamic budget” (survey). This limitation was reflected when the respondent from Center-4 described their informal science learning center as small, “with an even smaller marketing/advertising budget” (survey). Tight budgets and small staff made dedicating time to well-rounded social media plans challenging for participants within this case study. Regardless of budget or staffing limitations, respondents also reported that they knew they “should” have been implementing social media in a more consistent manner, which led to another code in the category of Ad hoc, unplanned social media use wrapped in guilt.

Some respondents relayed that social media was an essential element to the center, but the center lacked a formal implementation plan which led to them feeling some level of guilt about this situation. This burden is highlighted by the respondent from Center-4, who wrote in their online survey, “I now have to monitor social media at home, on weekends, on vacation, etc and try to respond to people as quickly as possible.” Their feelings of guilt seemed to be connected to the need for a quick response, but not having a formalized social media plan to use.

A quote from Center-7's respondent highlights the connection between lacking a formalized social media plan and the feeling of guilt: "we don't have [our social media] mapped out and we probably should" (survey). The respondent from Center-1 focused on their center's ability to modify the current trajectory of their social media, indicating, "we don't have a written plan as of yet" (interview). These respondent quotes illustrate that for centers in this case study, lacking a social media plan is understood as problematic and amends are being made to alleviate the problem. Ad hoc decision making, which is not an element of CMoL, seemed to control some of the ways respondents implemented social media, although it was not the totality of their social media use.

Sociocultural Context. The Sociocultural Context of CMoL involves understanding the connection between how a center is situated within a society and the ways in which those who visit such a center embody this relationship. Different approaches to social media can explicate this connection. The Sociocultural Context coding category addressed the ways centers viewed their roles in society and how these roles complimented the goals of their visitors. This coding category comprised 14% (n=10) of all data, with one main code, which we called *engaging on social*, dominating the coding category. The code engaging on social was delimited by using knowledge about each center's visitors and their places within the center's embedded social structure to elucidate the important relationship between the center and its visitors.

For this category, respondents explicitly connected the knowledge of their visitors with an intent to foster conversations based on the context of the center. This is exemplified by respondents indicating that they communicate by "comment[ing] on user-posted pictures" (Center-13, plan) because "comments are from supporters who have already had interaction of

some kind” (Center-8, interview). This differs from the Personal Context category where respondents reported intimate knowledge of their “audience,” suggesting that this knowledge ensured that connections could be created to individual motivations for visiting. By describing social media as a way to connect with visitors through conversations, this reveals that respondents felt that friendliness (i.e. commenting on posts) was required for meeting the needs of visitors, who were viewed as being already connected with the center. Within a center’s sociocultural context, being friendly could fulfill a social duty, serving to remind established visitors of the benefits of visiting or being affiliated with the center. However, the nature of comments crafted by centers were unclear—comments could have followed many tracks, including: merely acknowledging a visitor’s visit, querying the visitor to share knowledge, or clarifying the social duty of the center.

Coded instances of *engaging on social* featured some respondents discussing the ways their center coupled their social media communications with their audiences’ learning goals. Respondents from across our sample indicated the complimentary nature of the goals of their specific center and visitor goals, which would be described through engaging with visitors. An illustrative example of such complimentary activity includes the respondent from Center-5: “The plan for this year is to show the public (locals, visitors, donors, everyone) what [Center-5] is all about. Who are we? What do we do? Why? These questions will be answered through in-depth storytelling” (plan). The complimentary nature is also described by the respondent from Center-18, who wrote in their online survey “we and our managers feel that social media has become a primary method of initiating conversations about [Center-18’s] activities and events among [state’s] residents, because it reflects the way people are currently communicating and making

plans with family and friends.” In these ways, social media can allow for centers to establish or deepen the relationship between audiences’ ways of knowing and situation nature of a center within a particular society, a key aspect of the Sociocultural Context of CMoL.

Physical Context. The last element of CMoL, the Physical Context, can be described as the physical setting of a center that a visitor experiences. The physical setting constitutes the building and exhibits of a center as well as the aspects involved in navigating the physical space, including accessibility issues. This coding category was only used for seven percent of the total coding, which placed it at the bottom of all coding categories (n=5). Physical Context was dominated by the code *exhibit content*, which was delimited by respondents indicating that their centers used social media to showcase information about specific exhibits. For example, the respondent from Center-12 wrote in their online survey that social media was used to show information about “exhibitions, events, and programs” while the respondent from Center-13 explained that “social media [is used] to showcase exhibits (we don’t exhibit all we have)” (survey). Social media messages were composed by the respondent from Center-15 “based on check-ins with education, animal care, facilities, and volunteers” (survey). Such “check-ins” and concentration on exhibit content indicate that some respondents used social media to familiarize visitors with their physical space. However, even in the five written social media plans, little focus was given to familiarizing visitors to the museum space itself. When respondents described the idea of the physical space, they associated the physical space with the museum holistically, as Center-8’s respondent did, writing that social media focused “on [Center-8] as a whole, less on ‘attractions’” (interview). Noticeably, the coded segments within this category also did not describe the ways exhibits were designed to be accessible for all visitors, an aspect which could

be valuable to visitors who require specialized design (e.g., accessible flooring, aids for those who are visually impaired).

Discussion

The results of this case study suggest that for these 18 centers, social media is often used to support learning in limited ways, such as through the act of disseminating information to social media users. Though an amalgamation of concepts inherent to the CMoL were present, especially in regards to the personal context, the centers' social media strategies did not fully manifest key elements of the theory. Underdeveloped elements included those connected to the physical context, such as orienting visitors to the museum space through providing welcoming supports, including facilitating parking, online way-finding supports for exhibits, or providing information about specialized design accommodations the center employs. Social media strategies also did not fully align with the CMoL's sociocultural context, as most strategies focused exclusively on appearing as a friendly online entity instead of facilitating engaging conversations between visitors and the center. In addition, much of the centers' social media was not implemented strategically and did not seem to relate to their educational missions.

The main social media strategy, Knowledge Sharing, leveraged social media as a transmission point for information. Respondents indicated that centers approached social media as a dissemination tool which could ensure that the needs of a center are met (i.e. informing as many people as possible about an exhibit opening). However, this strategy does not recognize social media's full potential as no dialogue concerning the social media content can occur (Lee & VanDyke, 2015). In regards to the CMoL, Knowledge Sharing does not align to any learning context, since disseminating content does not account for the physical setting, the relationships

between the center and their visitors, nor take into account a visitor's personal motivations for visiting. The dissemination of center-focused content could drive traffic to the center itself, however, this approach fails to account for or to encourage appropriate forms of learning for these informal settings.

Although not as heavy-handed as the dissemination tactics inherent to Knowledge Sharing, the centers strategically used social media in an effort to convert followers into real-time visitors through courting individual interests. Respondents revealed intimate knowledge of visitors through their tailoring of content, a component of the Personal Context of CMoL. However, fully accounting for the personal context of CMoL would entail a center diversifying their social media content in order to address a social media user's life experiences, knowledge, and motivations, which would in turn be expected to influence their experiences within the setting itself.

A key element of the CMoL focuses on familiarizing the visitor to the physical space of a venue, which can contribute to learning, as people tend to learn better in familiar environments (Falk & Dierking, 2002; Falk & Storksdieck, 2010). The failure of these centers to use social media to familiarize visitors with their physical spaces represents an important loss of learning capacity (Falk, 2002). Therefore, an informal science learning venue can help their visitors learn better by providing visitors with the ability to familiarize themselves with the space. Often, this is accomplished by providing a map (at the front desk or on the web site) and/or staff to help visitors orient themselves. However, none of the strategies mentioned by the case participants involved contextualizing their venue's physical space through the use of social media.

While some aspects of the centers' social media strategies focused on uniting the interests

of the visitor with the needs of the center, most of the strategies relating to the CMoL's Sociocultural Context focused on the monolithic nature of different communities. While many of the respondents acknowledged their various communities, they failed to describe the ways their social media strategies integrate their centers within the sociocultural landscape. Within their discussions pertaining to the sociocultural context of CMoL, Falk & Dierking (2013) highlight the importance of community viewpoints concerning informal science learning centers, indicating that the focus of such centers should not just be on visitors "who show up at your door" (p. 81). This quote can be expanded to highlight social media use: informal science learning centers cannot establish the ways that their communities view them by merely connecting with people who show up on their social media pages.

As ASTC affiliates, missions for the centers of this study often reflect ASTC's principles and practices concerning educating the public through effective science communication. Yet, the social media strategies described by these centers were often unregulated, unstructured, and delivered in an ad hoc manner. Such practice is not likely to be successful for fulfilling their learning missions. The missions, principles, and practices that guide informal science learning centers are education-focused and employing CMoL-centered social media strategies could aid them in better serving their visitors. To help visitors enhance their learning through social media, informal science learning centers need to strategically develop social media plans that align with contemporary theoretical frameworks based upon learning in informal spaces, such as the CMoL. Social media offers real potential for furthering an informal science center's mission.

Implementing social media plans that are mission-based and steeped in contemporary learning theory that is appropriate for their context can positively impact learners as well as the centers

themselves. Melding informal science learning centers' social media strategies with contemporary learning models would better provide access to lifelong, lifewide learning experiences within the digital environment while also allowing centers to reach actual and potential visitors.

Conclusion

This case study of social media plans used in informal science learning centers bridges theory and practice regarding use of social media for learning in this setting. Our findings reveal these centers use marketing-related strategies for social media as opposed to learning related strategies. Key learning elements involving the personal and sociocultural contexts of the CMoL were identified, but were overshadowed by practices involving information dissemination such as knowledge sharing and an unplanned and unstructured approach. These issues could be addressed by applying a contemporary learning framework, such as CMoL in the design of social media plans as well as the subsequent practice. Doing so would improve the potential for informal science learning centers to achieve their learning missions.

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SUPPLEMENTAL DOCUMENTS

Survey Questions

1. Please provide information about the number of posts per week and which social media networks your institution uses.
2. Does your institution have a written plan?
3. What is the role of social media in relationship to the mission of your institution?
4. What kinds of goals are there? Are there goals for number of followers/likers/etc?
5. What do you consider as good engagement on a social media site like Facebook?

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