Describing the practices of members within one niche of social paleontology's digital ecology

Subject/Problem: Our purpose is to share results from a two-year long investigation by researchers on (XXXX), a National Science Foundation-funded project. This project operates within a digital habitat that emphasizes community through social technologies (Wenger, White, & Smith, 2009), consisting of various niches (i.e. distinct platforms for interaction). Each niche functions as an informal learning environment that focuses on building knowledge and relationships that center on community members' interests in paleontology. Community membership involves an expressed interest demonstrated through interaction, not a formal credential. This study is particularly concerned with the niche of (XXXX), a community-based interactive website designed by project researchers in partnership with a website developer. We investigated the following research question: what forms of social paleontological practice exist within (XXXX) website? In this presentation, we focus specifically on describing the member community as well as the practices exhibited during a two-year time period (October 2015-2017) where 263 members created over 3,500 pieces of digital trace data—records of activity within online systems that are patterns and processes of creating content (Howinson, Wiggins, & Croswton, 2011). These records took the forms of forum posts (n = 1,537), posts on an activity feed (n = 1,223), and private messages (n = 745). In particular, we describe a typology of members as well as their learning activities and how these activities develop over time within the context of the website. Using the techniques of social network and content analysis, we found that the greatest majority of members were members of the public, and that website members most often exchanged tips about paleontology, helped solve problems related to the domain, and left indications of their support for one another. We argue that our study provides empirical evidence for the digital practice of a natural science within an online community that is composed primarily of members of the public (58%). These findings are significant in that prior research on such online communities has emphasized social interaction with limited attention paid to the documentation of scientific practice or contribution.

Theoretical Framework: We situate this work within a socioconstructivist view on knowledge and learning, examining the knowledge-generating capacity of a digital community of practice (CoP) which allows for the examination of a group of people with a particular interest concerning a specific domain of knowledge. Wenger, McDermott, and Snyder's (2002) description of CoP serves as the theoretical framework for characterizing social paleontology expressed on the website. In this conceptualization, CoPs are defined by three essential components: the domain, people, and practice. A domain is the unifying component of CoPs, encompassing the shared interest of the community at hand. The domain is a unifying element of a CoP, as participation within the domain is theorized to occur due to a "sense of accountability to a body of knowledge and therefore to the development of a practice" (Wenger et al., 2002, p. 30). This quote shows that the domain supports another component of a CoP: the practice. Practice is qualified as the development of shared elements, both explicit and tacit, that embody participation in and contribution to the domain, including: stories, tools, language, documents, shared worldviews, and ways of addressing problems (Wenger et al., 2002). The last of the three components is implicitly connected to the other two components: community (henceforth people). People are those who engage in activities related to the CoP: having conversations about the domain, participating in the practice of the domain, and helping one another learn about the domain. Within a CoP, the people develop a sense of belonging within the community via their interactions, participation in, and contribution to the practices of the domain. This viewpoint of CoPs is further developed by Wenger et al. (2009) in the establishment of

a framework for learning activities within digital habitats. Analytically, we apply both the conceptualization of CoPs from Wenger et al. (2002) and the learning activities framework from Wenger et al. (2009).

Design (Methods, Design, Study Context): The (XXXX) website was designed to unite paleontologists within a digital space in the shared practices of social paleontology including the collection, identification, preparation, and study of fossils. Development of the website began in 2013 and followed a design-based research methodology (Author et al., 2016a). Data was collected from 263 website members who consented to participate during the two-year study period (October 2015-2017); part of the coalescing phase of community development (Wenger et al., 2002) and who contributed at least one piece of digital trace data. This study was primarily concerned with describing knowledge creation in a digital niche asking the central research question *what forms of social paleontological practice exist on the (XXXX) website?* To explore this line of inquiry, the research followed a single case study design that was bounded by membership in the (XXX) website (Creswell, 2011).

Using the results of a brief sign-up survey and individual member profiles, participants were characterized via the Paleontological Identity Taxonomy (PIT) (Authors, in review). The PIT involves a three-tiered hierarchy for classifying members based on their self-identification with the domain, which we view as an expression of practice-based expertise. The classification scheme starts with *structure*, which provides a coarse-grain classification consisting of three divisions (e.g., organization, individual) then *category* consisting of four divisions (e.g., public, scientist), followed by the finest grain, *types* consisting of twenty-five divisions (e.g., member of the public, K12 teacher).

Members' contributions to and participation in social paleontology are characterized through collecting and analyzing records of activity which were organized into three distinct categories: forum posts, activity posts, and member messages. On (XXXX), *forum posts* are topic-specific comments on a threaded discussions in which members create posts that other members can mark as personally important (favorite), keep up-to-date with (follow), and/or add additional information to (reply). *Activity* posts are original content created by a member that are situated within an area of the website other than a forum. Activity posts are either stand-alone content or replies to other members' posts. Lastly, member *messages* are private correspondences that originate from one member and are sent to one or more additional members. The message receivers have the option to respond to the message. These records of activity captured exchanges and musings of website members and as such, we used these data to characterize members' relationship with paleontology and to examine which members were participating in and contributing to the domain.

To accomplish this, we employed Wenger et al.'s (2009) learning activities framework, which describes how learning can occur within a CoP. For this study, learning activities and practices represent the same concept. Wenger and colleagues postulated that CoP members could enact seven categories of learning activities, with each category producing specific activities. Such digital practice categories as described by Wenger et al. (2009) are: *exchanges, productive inquiries, building shared understanding, producing assets, creating standards, having formal access to knowledge,* and *visits*. As an example of specific activities, news and information, pointers to resources/document sharing, stories, and tips are those that are nested within the learning activity of exchanges. Aside from giving name to these learning activities and specific activities, Wenger et al. (2009) leave further description open to interpretation. Becoming proficient in such learning activities is theorized as becoming a more complete member of the community (Wenger et al., 2002). Wenger's (2009) learning activities

framework was defined in terms of social paleontological-specific activities in order to create an analytical framework for describing practice within the (XXXX) website CoP (Table 1).

Analysis and Findings: When the PIT was applied to website members, we discovered members from all categories contributed some form of digital trace data (Figure 1). *Commercial* members—those who sell or collect fossils for commercialized purposes—were the least represented (n = 5). *Scientists*, members who work in scientific, academic disciplines, were second fewest (n = 44). *Education and outreach* members—those who work with paleontology in schools, teaching, or museums—were more highly represented (n = 62), whereas members of the *public*—those not meeting any of the previous criteria, made up the majority (n = 152).

Table 1: Modified Learning Activities Framework for the Category of Exchange*

Specific Learning Activity	Operational definition within (XXXX) website	Evidence
News & Information	Story about paleo for a lay audience or a general paleo resource, such as a geologic map or dissemination of recent org. activity, links to blogs	Not 100% scientifically accurate, but I hope you think she captured our enthusiasm and appreciation for this experience? I am messaging (redacted) as well because of the whole "burning the bone thing" :) http://bit.ly/2NGVZhW (Education and Outreach, Message Post #242)
Pointers to Resources/Doc Sharing	Dist. of PDFs, presentations, journal articles or other domain-related materials	You can also order photo scales with the geological time divisions on the back from the Geological Society of America http://bit.ly/2ubr9pu (Public, Forum Post #3299)
Stories	Person-centered account of social paleo practice	Makes me jealous, because I used to live along Rattlesnake Creek in Gainesville. All I ever found there were shark teeth, which are interesting in their own right, but not as interesting as a dugong (note my bias a mammalian paleontologist) (Scientist, Forum Post #9790)
Tips	Advice or best practice info to other member/s	It's hard to know for sure what kind of rodent it is because the teeth are diagnostic (Scientist, Forum Post #7098)

* Due to space constraints, only one of the seven learning activities specific activities is included in this proposal.

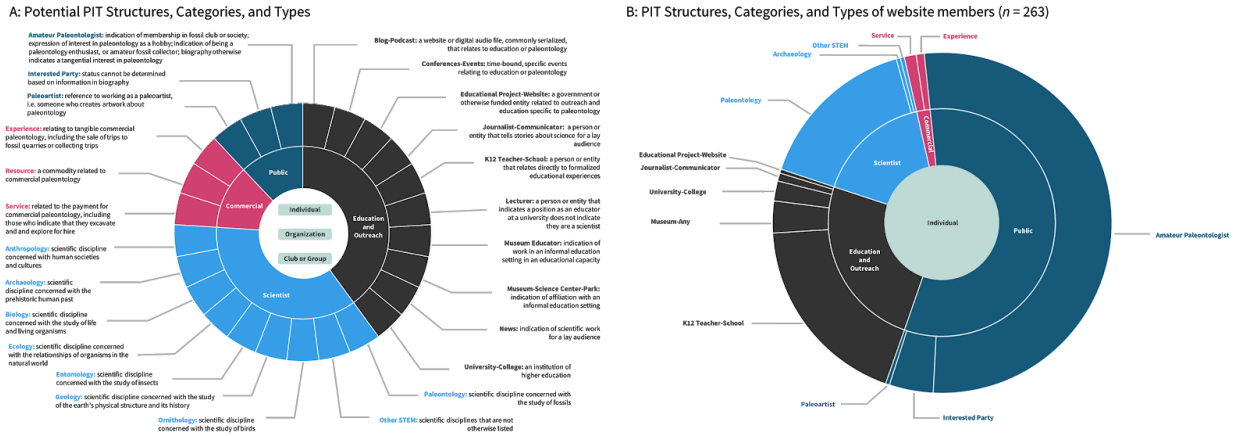

Figure 1: Paleontological Identity Taxonomy, generally and for website members

Following classification of members, all digital trace data were examined using Wenger et al.'s (2009) learning activities framework. Each piece of data was coded, some pieces included more than one coded learning activity. For instance, a single forum post that was four sentences long may have contained four different learning activity codes, or merely one learning activity code, depending on the content within the post. Therefore, the number of total coded learning activities exceeded the total number of pieces of digital trace data. A total of 3,827 individual codes were applied, divided between forum posts (n = 1,858), activity posts (n = 1,300), and messages (n = 669). Intrarater reliability was determined to be moderate or higher, depending on the digital trace data type examined ($\varkappa$ =.57 - .70). We describe findings dependent on the data type followed by findings across all three types (Table 2). Lastly, we contrast the differences and similarities across the data types in order to fully document the paleontological practice on the (XXXX) website.

Table 2: Learning activities and records of activity on the (XXXX) website

	Forums		Activity		Messages		Total	
Code	*n*	%	*n*	%	*n*	%	*n*	%
Joint Events	72	3.8	47	3.6	15	2.2	134	3.5
External Benchmarks	4	0.2	0	0.0	0	0.0	4	0.1
Models of Practice	54	2.9	9	0.7	6	0.9	69	1.8
News + Info	82	4.4	62	4.8	7	1.0	151	3.9
Pointers to Resources	140	7.5	53	4.1	6	0.9	199	5.2
Stories	231	12.4	114	8.8	68	10.1	413	10.8
Tips	228	12.2	137	10.5	130	19.4	495	12.9
Formal Practice Transfer	33	1.7	12	0.9	2	0.3	47	1.2
Help Desk	189	10.2	69	5.3	80	11.9	338	8.8
Boundary Crossing	36	1.9	10	0.8	1	0.1	47	1.2
Collaborations	53	2.9	44	3.4	63	9.4	160	4.2
Collections	0	0.0	0	0.0	2	0.3	2	0.05
Documenting Practice	99	5.3	70	5.4	18	2.7	187	4.9
Problem Solving	201	10.8	169	13.0	82	12.3	452	11.8
Exploring Ideas	161	8.6	145	11.1	37	5.5	343	8.9
Field Trip Planning	10	0.5	74	5.7	9	1.3	93	2.4
Support	265	14.3	285	21.9	143	21.4	693	18.1
Total	1858	100.0	1300	100.0	669	100.0	3827	100.0

Within forum posts (n = 1,858), the learning activity of *support*—members thanking others for contributing, acknowledging a contribution or being otherwise social without adding to knowledge per se was added after a first pass at the data, occurred most frequently (14.3%, n = 265). *Stories*—person-centered accounts of social paleontological practice—represent the second most frequently coded learning activity (12.4%, n = 231). Following stories was *tips*, third in prevalence (12.2%, n = 228). Tips occurred when members provided advice or best practice information to other member/s. *Problem solving*—communication concerning solutions related to the domain, (10.8% , n = 201) and *help desk*—inquiring about domain-related topics, most often the identification of specimens (10.2%, n = 189) were the only other learning activities occurring with frequencies higher than ten percent. These percentages show that for forum posts, members were focused on providing non-scientific community-based support to one another, telling personal paleontological accounts about the domain, and producing solutions to domain-specific problems through advice, communication, or the distribution of materials.

Activity posts, or data which occurred in public spaces of the website with the exception of forums, followed similar patterns to forum posts. Overall, there were 1,300 coded instances. The most frequently coded learning activity was that of *support*, consisting (21.9%, n = 285). The second most frequently coded learning activity was *problem solving*, although the percentage drops to 13% (n = 169). The third most frequently coded learning activity was *exploring ideas*, a learning activity in which members brainstorm about the domain, not necessarily seeking answers (11.1%, n = 145). The only other learning activity that occurred in a frequency higher than ten percent was *tips*, making up 10.5% (n = 137). These percentages highlight the ways in which members used the activity feed

as a place to appreciate one another socially, to communicate about the domain, to brainstorm, and to provide advice to others about the domain.

Lastly, the data type of messages also followed a similar pattern to the other two data types. Overall, there were 669 coded instances. Within messages, there was a high frequency of *support* compared to any other learning activity types. *Support* consisted of 21.4% of all coded learning activities (n = 143) followed by tips, the next most frequently coded activity (19.4%, n = 130). The only other coded learning activity which showed up with regularity was that of *problem solving*, appearing 12.3% of the time (n = 82). These data show that within messages, members were explicitly focused on providing advice to one another, perhaps in lieu of other learning activities.

Overall, our findings show that the forms of social paleontological practice that exist on (XXXX) website are personal, related to sharing advice, and concerned with producing or at least exploring new ideas related to social paleontology. Furthermore, these findings highlight the ways in which (XXXX) members communicate on a science-specific website. Although domain-specific, a majority of the communication took the form of social support. Within the CoP framework, this indicates a sense of focus as well as ownership and openness, which are hallmarks of the later stages of development in a CoP (Wenger et al., 2002). Through this study of the (XXXX) website, we can highlight the ways in which a science-specific community develops and thrives.

Contribution to Teaching and Learning of Science: The results of this study make an important contribution to the teaching and learning of science by offering insight into digital forms of scientific practice in a non-formal environment that is largely composed of members of the public, as previous research is largely descriptive and focused on social relationships. Studies with thick and rich descriptions of contexts highlight the complexity of situations in which learning develops. However, these descriptive studies do not capture the reasons why CoPs flourish or fail. The work presented here attempts to both contextualize a domain-specific CoP and present evidence for such a CoP acting as a practice-based knowledge-creating space. This study continues an exploration of social paleontology, an open, inclusive, social, and collaborative form of scientific practice that is open to citizens of all backgrounds.

Interest to NARST members: This study speaks to this year's conference theme by highlighting contributions and collaborations within science learning from people of diverse learning backgrounds. The knowledge creation capacity of (XXXX) members, i.e. between scientists, education and outreach members, commercial paleontologists, and members of the public, represents a microcosm through which we can view collective activism. Rudolph and Horibe (2015) indicate that science-related civic engagement (i.e. collective activism) must include the use and production of scientific knowledge. Understanding and communicating the scientific importance of fossils within a digital CoP can provide development of best practices concerning science-related civics issues. It will be of particular interest to members interested in addressing difficult problems in science education through the research and development of online learning environments.

Selected References

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