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Geolearners: Location-based Informal Learning with Mobile and Social Technologies

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Abstract-- This paper looks at how mobile and social technologies are influencing informal learning in the context of online community membership. The development of mobile technologies that use Global Positioning System (GPS) data to pinpoint geographical location together with the rapidly evolving Web 2.0 technologies supporting the creation and consumption of content suggest a potential for collaborative informal learning linked to location. The research described in this paper asks whether these technologies can provide an effective focus for community activities and, if so, whether this combination of location-awareness, mobile and Web 2.0 technology results in the creation of novel informal learning opportunities. The community selected for study was the Geocaching community, a geographically dispersed group who use mobile and Web 2.0 technologies to link the virtual social spaces of the internet with the physical spaces that surround them..

Index Terms--knowledge sharing, mobile and personal devices, social learning techniques

I. INTRODUCTION

Beginning with the premise that knowledge is socially constructed and that learning may be accomplished through collaboration [1], [2], [3], [4], this study looks at the learning opportunities that arise through membership of an online community that relies upon and is defined by the rapidly evolving social and location aware mobile technologies, the Geocaching community. In particular, it reveals how the interplay between mobile and Web 2.0 technologies, location and community members leads to informal learning opportunities [5], [6].

Web 2.0 refers to internet-based technologies that facilitate creativity, information and knowledge sharing and collaboration. The term Web 2.0 was originally coined in 2004 by Dale Dougherty, a vice-president of O'Reilly Media Inc. to refer to the *outcomes* arising from a range of applications and services that support content creation, information sharing and end-user creativity [7]. Use of the term outcomes is deliberate; Web 2.0 is not any single collection of

applications or technologies, rather it is the set of collaborative activities and creative products that are enabled by these technologies. "*Web 2.0 is an attitude, not a technology*" [8].

Fischer and Scharff suggested that "*New technologies and learning theories must together serve as catalysts for fundamentally rethinking what learning, working, and collaborating can be and should be in the next century*" [9]. The lack of empirical data on the educational implications of Web 2.0 [10] reveals a need for research into the impact of Web 2.0 technologies on learning. In particular, into what impact they are having on the practices of online communities and whether they have played a role in informal learning through knowledge creation and sharing. The study described in this paper investigates the learning opportunities encountered by Geocaching community members as they use location aware mobile technologies and Web 2.0 technologies to support community activities, thereby creating "*new sites for learning*" [11].

Geocachers form a geographically distributed community who use mobile and Web 2.0 technologies coordinate and document their activities, linking the collaborative virtual spaces of the internet with location-specific physical spaces. Geocaching is essentially a form of GPS-guided treasure hunt in which participants hide Geocaches and provide their location coordinates via a cache description on the website so that others can use GPS devices to guide themselves to the cache location. The traditional Geocache is a box containing a log book and items to swap. Other types of Geocache include puzzle caches, where you need to solve clues to reveal the location of the cache, Earthcaches, where the aim is to learn something about the environment, virtual caches and many more.

Upon finding a cache, a Geocacher signs the paper log book to prove that they've physically been there and then accesses the Geocaching website to log their find with a short description of the experience and any images they want to upload. They can do this either using mobile

connectivity or when they return to a computer. Each find log is linked to the Geocacher's own profile on the website, providing an up-to-date record of the number of caches found as well as appearing as a dated log entry on the cache description page.

The Geocaching website and associated web forums act as a repository for the collective resources of the Geocaching community and provide an online record of the interactions that members have with each other, with location, and with the website and forums. Community members use technology to share their experiences and knowledge of place, connecting physical and virtual spaces through the creation of a persistent digital narrative of location. In this paper, the phrase *persistent digital narrative of location* is used to describe an online resource created collaboratively over time through the accumulated contributions of community members. It is stored on the Geocaching website and consists of text, images and hyperlinks to external resources that connect individual Geocachers with each other through their shared experience of location. In contributing to this persistent digital narrative by logging their cache finds and uploading images and links to the website, Geocachers create and share knowledge linked to location, and in so doing, encounter a variety of informal learning opportunities.

Informal learning has been identified as a widespread phenomenon since the 1970s [12, [13], [14]. At its simplest, informal learning may be seen as any learning that takes place outside the formal curricula of schools or higher education. It may be intentional, self-directed, unintentional or tacit. One of the defining characteristics of informal learning is the learner empowerment that arises from the absence of an external directing force (teacher, lecturer, curriculum designer) directing what should be learned and how best to learn it. Without this formal, externally imposed framework, informal learners make their own choices both about what they will learn and what techniques and technologies they will use to support their efforts [12]. Therefore, by

elaborating the ways that informal learners are choosing to use mobile and Web 2.0 technologies, we can extend our understanding of the learning potential of such technologies.

II. FRAMEWORKS FOR ANALYSIS

Communities of Practice theory [15] views learning as a by-product of community membership and has been used to analyse informal learning through online community membership [16]. Wenger suggested that a community of practice was not fixed, relying instead on a changing membership as newcomers set out on an "*inbound trajectory that is construed by everyone to include full participation in its future*" [15]. The journey from novice to experienced community member involves learning [15], [17]. This learning may consist of practical skills, problem-solving skills, cultural practices and conceptual knowledge at different stages during the journey. Jonassen et al., paraphrase this learning process, pointing out that "*learning results naturally from becoming a participating member of a community of practice*" [2].

Wenger's view of community membership as a trajectory that presents opportunities for learning underpins the research described in this paper. It aims to identify informal learning opportunities arising out of location-related activities by looking at the typical membership trajectory of a Geocaching community member, from starting out to developing into an experienced Geocacher. To do this, a framework was needed that would both highlight the changing learning opportunities that occurred during this membership trajectory and reveal the social implications of Web 2.0 technology use.

Such a framework was proposed by Preece and Shneiderman [18] who sought to extend our understanding of the social implications of Web 2.0 by examining the motivation underpinning collaboration and participation in online communities. They pointed out that although Web 2.0 is "*the social web*" that there are "*many social applications that aren't social at all. Nothing is*

happening" [18]. By synthesising over 60 pieces of literature on online communities, they were able to characterise community membership into four stages of participation, referred to as the Reader to Leader framework [18].

Stage 1. Reader – first experience, venturing in

Stage 2. Contributor - returning & becoming a contributor

Stage 3. Collaborator - becoming a regular contributor

Stage 4. Leader – prolific contributor, identifiable, credible

These four stages were used as the framework for the analysis in this paper. Learning opportunities are likely to evolve as people become more familiar with the activities of the community and therefore a framework that viewed community membership as a temporal journey offered the best approach for identifying these opportunities as they occurred.

Jonassen et al., [2] applied a constructivist perspective to the use of technology in schools to create technology-based activities that would support meaningful learning. Jonassen et al., defined meaningful learning as occurring when students were actively engaged in making meaning, and broke down this definition into five "*interrelated, interactive, and interdependent attributes*" [2] with the most meaningful learning activities supporting combinations of these attributes. The five attributes were Active (manipulative, observant), Constructive (articulative, reflective), Intentional (reflective, regulatory), Authentic (complex, contextualised) and Cooperative (collaborative, conversational).

Jonassen et al., proposed a shift in the way educators conceive of technology use in education, suggesting that they "*begin to think about technologies as learning tools that students learn with not from*" [2] and this perspective matches the ways in which technology is likely to be deployed by informal learners who are unconstrained by externally imposed formal learning structures.

Therefore, Jonassen et al's five attributes of meaningful learning are used to classify the informal learning opportunities identified as a new member of the Geocaching community progresses through the stages of community membership.

III. METHODS

This research used the internet as both a data source, and as a way of locating and recruiting participants from the worldwide Geocaching community. It employed three methods of data collection:

- Web survey – an online questionnaire providing self-reported data on the target research areas of mobile and Web 2.0 technology use and informal learning.
- Geocaching community resources and outputs from the Geocaching website and forums
- Case study interviews of five participants selected from the web survey respondents

Participants were invited to follow a link to an online web survey containing questions about their Geocaching experiences. The questionnaire contained 52 questions which consisted of 25 radio buttons (click on one), 3 check-boxes (click on all that apply), 20 free text (type as much as you want) and 4 optional follow up questions (email address, name, website, Geocaching ID).

The web survey was divided into four sections. Section 1 contained general questions designed to elicit information about how the Geocacher got started, how often they went Geocaching and how many caches they had found and hidden. Section 2 asked about any informal learning that participants felt had occurred as they hunted for Geocaches. Participants were asked both quantitative (yes/no) questions and qualitative questions so that those who wanted to contribute more information about their learning experiences could do so through the free text responses. Section 3 focused on Earthcaching, asking similar questions about learning experiences through seeking and creating Earthcaches. Section 4 asked community-related questions designed to

obtain information about the types of interpersonal interactions that occurred as a result of Geocaching, with a view to analysing the nature of this links between people in this hybrid virtual/physical community. It also asked questions about activities that extended beyond the defined Geocaching community, offering alternative forms of community interaction such as blogging and photoblogging. Demographic information was collected at the end of Section 4.

The survey was live for 3 weeks in July 2007 and generated 659 responses. Many participants gave full and detailed accounts in response to the free text questions, generating over 107,000 words of qualitative data. The data were analysed using qualitative techniques and coded according to Jonassen et al's five attributes for constructive learning with technology.

IV. ANALYSIS

The learning opportunities are identified in relation to the membership trajectory from Reader in Stage 1 through to a leadership role in Stage 4. These learning opportunities are then compared to Jonassen et al's five attributes of constructivist learning with technology [2].

The concept of location is key to all Geocaching community activities, acting as the focal point for the Geocache hunt, and the virtual locus for the creation and storage of information related to that location. This interweaving of the virtual and the physical distinguishes the Geocaching community from other online communities and offers novel ways of creating and maintaining cohesive social networks together with new opportunities for informal learning.

These opportunities for informal learning include both those with a clear skills focus such as learning to use a GPS device, learning to read and interpret geographical coordinates and learning the ability to spot a well-hidden Geocache, as well as incidental informal learning opportunities that are inbuilt in the activity of Geocaching. For example, learning more about the history of an area, or learning about the geographical and other processes that have formed the

landscape. The learning opportunities occur at different points during the stages of community participation, and involve mobile and Web 2.0 technologies to varying extents.

V. STAGE 1: READER

Stage 1 of Preece and Shneiderman's four stages of community participation suggests that for an online community to be successful at retaining new members, the website content needs to be attractive, relevant and easy to access [18], [19]. A key facet of Stage 1 of community participation involves newcomers beginning by reading the website content and then participating [18]. By creating a Geocaching ID the newcomer gains full access to all the community resources and opens lines communication with other members of the Geocaching community.

A. *Learning Opportunities during Stage 1*

The learning opportunities at this exploratory stage in community membership are intentional, deriving as they do from an individual's goal of learning more about Geocaching. The individuals regulate their own learning as they choose what links to follow to obtain more information. At this stage, the information flow is from the website to the individual and use of the technology (webpage and links) is key to attaining the learning goals. This relationship between use of technology and learning about Geocaching is evident to the learner who engages consciously with the technology in order to achieve a goal.

In describing the Cooperative learning attribute, Jonassen et al., highlight the tendency for humans to "*naturally work in learning and knowledge-building communities, exploiting each other's skills and appropriating each other's knowledge*" [2]. Jonassen et al's rubric for assessing cooperative learning describes a situation in which learners have access to others who are engaged in similar learning opportunities at the same time, describing cooperative learning as "*collaborative/conversational*", adding that "*Collaboration most often requires conversation*

among participants. Learners working in groups must socially negotiate a common understanding of the task and the methods they will use to accomplish it” [2]. Informal learning opportunities do not always occur when people are in the same physical or virtual space at the same time. Therefore opportunities to work together synchronously on a shared understanding of tasks and methods to accomplish tasks may be limited.

However, there is an element of cooperative learning present at this early stage of community membership. The novice Geocacher is trying to learn more about Geocaching. In browsing the Geocaching community website, they are using resources created by other more experienced Geocachers, in effect, developing a shared understanding of Geocaching. This community participation in the creation of shared resources is made possible by Web 2.0 technologies in which individuals make material available to be used and modified by others.

Geocachers tend to pass swiftly through Stage 1 of the membership trajectory. Unlike an online community where the main contributions take place through forum postings, the main contributions in Geocaching take place as a result of seeking out, finding and logging a Geocache. A Geocacher may be an active member of the community yet never post a message on the forums. The increasing learning opportunities encountered as a Geocacher moves Stage 2 of membership are described below.

VI. STAGE 2: CONTRIBUTOR

Stage 2 of Preece and Shneiderman’s four stages of community participation involves returning and becoming a contributor. In the Geocaching community, having created a Geocaching ID, the new Geocacher can engage with the community progressively by:

- Seeking advice via a message in a Groundspeak forum, thereby engaging in a dialogue with other community members.

- Seeking, finding and logging a Geocache.

Participants were allocated to Stage 2: Contributor if they had found and logged a Geocache because logging a cache represents a contribution to the persistent digital narrative of location and creates a connection between the novice Geocacher and the online community. According to this metric, 99% of web survey participants (n=659) had reached the Contributor level of community membership, having gone Geocaching and found and logged at least one cache.

This rapid progression from Stage 1, Reader to Stage 2, Contributor, may be related to the reasons people went to the Geocaching website. In response to the question “*Why did you start Geocaching?*” 34% (n=631) said that they had acquired a GPS device and were looking for an activity that they could use it for. Communications media was listed by 21% (n=631) who described reading about Geocaching in a magazine, hearing it mentioned on TV or by following a webpage link. Friends could also be influential, with 18% (n=631) introduced to Geocaching by a friend or family member. Having read about Geocaching on the website, the nature of the activity (getting outside into the landscape) influenced some to continue, with 20% starting because they wanted to spend more time outdoors, 13% wanting to visit new places, 13% looking for an outdoor activity that they could do with their children and 11% hoping that Geocaching would encourage them to exercise and get fitter. Participants often gave more than one reason for starting Geocaching, so the totals do not add up to 100%. Geocachers tend to join the community because they want to engage in the physical activity of Geocaching by finding a Geocache, and this leads them quickly to Stage 2, Contributor.

Interestingly, given the focus of this research, only 4% (n=631) of participants named learning as a specific reason for starting Geocaching, yet 89% (n=659) reported that they had learned something as a result of Geocaching. Examples of the sorts of learning opportunities described

by Geocachers are provided in subsequent sections.

Membership of Geocaching.com gives access to all the community areas including the threaded discussions on the community web forums. The forums support learner directed conversational learning [20] in which new members can engage in asynchronous dialogues with more experienced Geocachers to clarify their understanding of what it is to become a Geocacher and get subject-specific help on topics of their choosing. The first discussion topic displayed on Groundspeak forums is *Getting Started*.

Data were collected about the Geocachers who initiated threads in the Getting Started Discussion between 26th and 28th October 2008. There were 32 new threads. Of these, 38% (n=32) were posted by newcomers who had joined the community in the previous 30 days. A further 31% (n=32) were started by Geocachers with less than 6 months in the Geocaching community and the remainder by those with over 6 months membership.

In terms of Geocaching experience, analysis of the Geocachers' profiles revealed that 14% (n=32) of the thread starters had not yet found a Geocache. These posts were sometimes from Geocachers who had tried and failed to find caches asking for techniques to help them search. Sometimes they were posted by new Geocachers seeking advice from the community before setting out on their first Geocaching attempt, often asking for recommendations on which GPS unit would be best.

Although many new Geocachers simply go Geocaching without seeking any further help or advice, the analysis of the Getting Started form threads between 26th and 28th October 2008 supports the claim that the Getting Started forums are used by novice Geocachers looking for advice from other community members. They provide a supportive online environment in which new members can learn from more experienced members. Use of the web forums to get help

with Geocaching-related problems matches all five of Jonassen et al's attributes of constructivist learning with technology.

1) Intentional Learning Opportunities

In using the Getting Started forum to ask a question or describe a problem, Geocachers have set some form of learning goal. They regulate their progress toward their goals through postings in the forum thread and discuss their processes and strategies with other forum members, monitoring their progress toward a solution. Technology is key, both in supporting the discussions on the forums, and in providing the means by which members can go out and try out what they have learned on the forum.

2) Active Learning Opportunities

The problems encountered by novice Geocachers relate to the real world context of Geocaching. They include how to interpret the information on a GPS unit, how to upload pictures to the website or techniques and skills needed to find a Geocache. The conversational structure of the forum threads encourages observation and reflection. Novice Geocachers try out suggestions, observe the results and reflect upon the success or failure through posts in the forum, obtaining further help from more experienced Geocachers if necessary. The activity of Geocaching involves going out into the environment, making effective use of cognitive tools such as GPS devices and maps.

3) Constructive Learning Opportunities

Novice Geocachers are deliberately seeking to learn in order to resolve some sort of Geocaching-related problem. In doing so they engage in a meaning-making process whereby they map the mental models they develop through the forum conversations onto their observations and experiences when Geocaching, constructing new mental models as they do so.

4) Authentic Learning Opportunities

The challenges faced are situated in the real world context of Geocaching. Although the activity of Geocaching is artificially constructed by Geocachers for other Geocachers, the

practice of using GPS technology to hunt for a location, aided by the description and narratives on the cache webpage involves the exercise of practical skills and higher order thinking in order to be successful. Each Geocache is different, therefore each challenge present different problems, some of which will be new to the learners and all of which require complex solutions.

5) Cooperative Learning Opportunities

The forum acts as a source of socially negotiated understandings through which all participants can build on and learn from their own and each others' knowledge to construct new knowledge. This conversational learning is inbuilt into the activity of participating in a Getting Started forum. Cooperative learning opportunities occur both for the novice forum members who post questions as well as experienced Geocachers who can learn from the responses of other Geocachers or from the reported experiences of the novices. Social negotiations take place via the web forums in which the ideas of all participants are discussed and valued. Roles and responsibilities shift with ease – a novice Geocacher may be able to act in an expert role by sharing their experiences of a similar problem in response to a request from another member. Equally, experienced Geocachers also post to the Getting Started forum if they need help with some aspect. This deliberate cooperation through asynchronous interactions, together with the explicit negotiation and renegotiation of roles and responsibilities maps readily onto Jonassen et al's rubric for assessing cooperative learning with technology. However the physical activity of Geocaching offers additional learning opportunities, described below.

B. Seeking, Finding and Logging the Geocache

Hunting for a nearby Geocache is often one of the first Geocaching experiences a new Geocacher has. By selecting a location of interest, the new Geocacher is contextualising the information they receive from the website, making the first link between the virtual community of Geocachers and physical location. The next step is to download the coordinates to the GPS

device and download the description either to a device such as a Personal Digital Assistant (PDA) or print it out on paper. The novice Geocacher is now in a position to go out to seek the cache.

Most Geocache descriptions provide one or more starting points from which to seek the cache. These may be a car park or other easy to find landmark such as a church. From this point, Geocachers use the GPS device to guide them to the location of the Geocache.

1) Intentional Learning Opportunities

The most obvious intentional learning opportunity arising out of joining the Geocaching community is that of learning more about Geocaching, or how to go about it. Becoming a member can act as a trigger for informal learning, for example: *I have read two books specific to GPS technology and Geocaching since I have started* (Survey response 538)

Certain types of Geocache involve a deliberate learning goal, created by the person who set the cache. For example, the aim of Earthcaches is to teach people something about how the forces that shape the landscape. The success of this aim is reflected in the web survey responses in which 74% (n=336) felt they had learned as a result of seeking an Earthcache. (n=336 reflects the fact that only 336 of the web survey respondents, about half, had searched for an Earthcache).

We went to an Earthcache that involved dinosaur tracks and we have several small children and they learned from that experience. (Survey response 374)

Earthcaches are quite often very interesting and its definitely a way to improve knowledge and also it makes learning fun. You definitely remember things that you have learnt about, i.e. rocks and glacial formations when you have visited a site and seen an example. (Survey response 382)

These learning opportunities may extend beyond the experience of seeking the Earthcache, resulting in intentional informal learning opportunities that take the form of research both before

and after the event:

In Colorado Springs, caches led us to Garden of the Gods, which we then explored more fully, including the museum. (Survey response 52)

Garden of the Gods Earthcache is a good example. I did a little bit more reading both before and after about the area and the geology. (Survey Response 109)

Solving the challenges devised by the creators of puzzle caches may also result in learning opportunities:

We think that puzzle caches which require you to search the internet are often excellent for expanding your knowledge. We have often gone beyond the answer required to find out more just for our own interest. (Survey response 211)

Some hightech caches have an inbuilt requirement to learn something new in mathematics and information technology. However even the traditional cache consisting of a box or container hidden somewhere in the landscape also presents learning opportunities linked to the location. Geocache creators can put considerable efforts into creating caches that give an interesting and educational experience to the Geocachers who seek them. The first part of this experience involves reading the Geocache description. This may present a learning opportunity in itself. Geocaching can also trigger deliberate informal learning activities that complement the Geocaching activity:

Not only have we picked up interesting bits of history, but we have actually gone out of our way to develop skills for Geocaching. My wife and I have taken classes to learn to rappel for Geocaching, we have also learned how to kayak, studied plants and animals and trailcraft, we have taken classes on field first-aid in order to help out other people we hike with. Geocaching has really been a great inspiration to learn for us. (Survey response 71)

Finding the Geocache and experiencing the location also inspire follow-on research. 73% (n=659) responded “yes” when asked if they’d been inspired to follow up in some way as a result of Geocaching for example a cache placed in a historical site or an area of great natural beauty.

We have also bought a book about wild flowers and reptiles so that we can identify plants reptiles that we see on the trail. (Survey response 108)

Many times we have come back and 1) looked up initials on a gravestone; 2) researched a specific park area for more information regarding its background; or 3) researched a specific event referenced in a cache site. Mostly it is internet research; however several books have been purchased in the efforts. (Survey response 612)

A virtual named We Three Kings inspired me to read the War of the Copper Kings and learn more history about Montana. We also enjoyed a Gandhi inspired cache in a peace garden which inspired my husband to pick up Gandhi's autobiography. Another cache, a virtual in New Orleans whose name I cannot remember, inspired me to read the book A Confederacy of Dunces by Toole. (Survey Response 49)

The informal learning efforts described above are intentional. However many learning opportunities that occur when Geocaching are unintentional learning opportunities. That is to say, the Geocacher did not set out with the intention to learn, but was presented with an unexpected learning opportunity as part of the experience.

One cache my family and I found on vacation had a magnificent birds nest within sight of the cache. After snapping several photos, we researched bird-watching sites to identify the type of bird it was. We thought it might have been an eagle but after about an hour we decided it was an Osprey...we would have NEVER done anything like that without caching. (Survey response 455)

Some Geocaches have taken me to beautiful places I didn't know existed. Such as neat nature

preserves, historical sites, etc... Return visits allowed me to further explore the area. (Survey response 473)

Classifying meaningful learning as intentional works when applied to informal learning opportunities that require intent on the part of the learner. For example, engaging in research about a location before seeking a Geocache, or looking up more information after having found the Geocache. However many informal learning opportunities described by participants are unintentional yet perceived as meaningful by the learners.

2) Active Learning Opportunities

Geocaching is an activity that involves using information provided by others to get outdoors and hunt for Geocaches in the landscape. This requires a variety of tools. Technological tools include the Geocaching website through which the cache is selected and from which the information is downloaded, and mobile devices including some form of GPS device with which to navigate across the landscape to locate the cache and maps, either electronic or paper. Combining these artefacts in the real-world context of a Geocache hunt offers many active learning opportunities. Primarily amongst them being how to effectively use the tools. This was reflected in the free text survey responses to the request for details about what people learned when Geocaching.

Learning how to use a GPSr and map and compass skills. (Survey response 121)

Better familiarity with land navigation techniques without the use of a gps (Survey response 325)

How to navigate better and use of maps (Survey response 202)

By logging the find, and posting up photos, a Geocacher reflects and reports on the experience. However Geocaching as part of a family or friendship group offers additional opportunities for discussion and reflection during the activity.

I know my children have learned a great deal. While out in nature, I have a great venue in which to teach my children about animal and plant life, history, geology, history, technology, and even mathematics and cryptology. (Survey response 106)

I think that most caches teach our children something about the world about us, whether geology, history, nature, etc. There is also the aspect of learning about conservation and caring for the things about us; and about how to be safe when out and about; and of course navigation, distance, bearings and reading maps correctly. Probably the best thing is that we interact with our kids whilst out caching and share the experience as a family. (Survey response 229)

3) Constructive Learning Opportunities

Geocaching is a leisure activity with no external force driving individuals to join in. Any informal learning opportunities that they take up result from intrinsic interest, rather than extrinsic compulsion. This constructive approach was reported both for adult Geocachers, and their younger family members:

I have a 7-year-old who is getting very good with a gps and starting to understand compass and map work. (Survey response 555)

My family has learned to use GPS. (Survey response 361)

My daughter says she learned not to give up. My kids learned that the GPS equipment is only so accurate and reliable and that you cannot rely on this measuring device to pinpoint a cache. You must eventually open your eyes and search for logical places. (Survey response 243)

Geocaching is fundamentally an activity built around sharing experiences of location and real-world problem solving. Both through learning how to use GPS to successfully find a cache, and by solving the challenges explicitly built into certain cache-types, Geocachers engage in meaning-making activities to create their own understandings. These activities are informed by the cooperatively constructed information provided by other Geocachers as well as by the

characteristics of the locations they visit.

4) Authentic Learning Opportunities

Geocaching presents real-world challenges. These vary according to the cache, but they often involve learning opportunities in a range of subjects. For example:

Puzzle caches in particular have given me the opportunity to learn about different languages, encryption methods and historical information. For example, a cache in my area is related to the methods of encryption used in WWII and the method that British soldiers were able to break the Lorenz cipher. I have not solved this puzzle yet, but I have learned a lot about history which I had either never learned, or forgotten. I also solved a puzzle which required learning the Babylonian number system. (Survey response 53)

Yes - a magnet based cache in particular stands out. I only did science to GCSE level, but I don't ever remember being taught that magnetic power was accumulative. I did a cache where there was a +3 magnetic power holding a cache in place, and you could only swap the polarity on two of the magnets. Where could you find something else to remove the magnetic power out here in a wheat field? We did it! (Survey response 136)

Because Geocaching is set in the real-world context of seeking out hidden locations in the landscape, the problems and challenges encountered are authentic. In addition, when setting the Geocache, community members use the features of the landscape in order to increase the challenge and adventure, thereby ensuring that the experience is enjoyable.

5) Cooperative Learning Opportunities

Once Geocachers join the online community and engage with other members via the web forums, they encounter cooperative learning opportunities. These opportunities intensify as they seek the Geocache and return to log it on the website. However Jonassen et al's [2] definition of cooperative learning relies on a learning situation in which learners have access to others who are engaged in similar learning opportunities at the same time, along with interactions with

experts. Informal learning opportunities do not always occur when people are in the same physical or virtual space at the same time. Therefore opportunities to work together on a shared understanding of tasks, or to shift roles and responsibilities may be limited. If a Geocacher is seeking a Geocache in the company of others, then it is easy to see how this would offer cooperative learning opportunities. For example:

When hunting caches with groups it requires lots of teamwork. Whether we find it together or don't find it all, the team enjoys the success and not one individual. (Survey response 567)

At times caching partners are very knowledgeable in geology, biology, botany and other things, even just the history of the area. As we hike each person imparts his/her knowledge of the area or surroundings. (Survey response 266)

These quotes demonstrate how groups of Geocachers interact with others in activities “*in which collaboration results in success*” [2] and engage in negotiation in which all members ideas are valued and roles and responsibilities are distributed throughout the team. However even in these examples of cooperative Geocaching, it is difficult to pinpoint any explicit *interaction with experts* which was one of the criteria used by Jonassen et al. to identify cooperative learning. This interaction with experts takes place in virtual space, rather than in physical space, through use and assimilation of the cache description (written by the “expert” who set the cache) and by viewing the logs and images of Geocachers who have gone before. There may also be direct email communication with the cache owner, for example solving some form of challenge related to the cache location and emailing the response to the cache-owner in order to log the find. These virtual forms of expert interactions are a feature of the Web 2.0 technologies that are embedded in the activity of Geocaching.

Cooperative learning opportunities are also encountered by Geocachers who cache solo. They

are not obviously interacting with others in the same way as groups of Geocachers. However the information they are using to inform their experience of location was created cooperatively by other members of the Geocaching community. When they log their find and upload photos, they are contributing to that persistent digital narrative of location, creating a richer picture of that location for others. This contribution may even evolve into changes to the cache description and learning opportunities for the person who hid the cache:

Visiting a cache early in the morning in winter I was joined by an elderly gent who was at the same spot to do Tai Chi. We chatted I told him what I was up to and he explained some of the historical significance of the site. The cache setter had not known of the significance of the place. It was both an ancient route out of the city and had featured in a book by R L Stevenson. I posted this in my log and the setter subsequently amended the cache page. (Survey response 217)

Thus, as a result of the contributions of somebody who found the cache, the role of the person who hid the cache moved from that of contributor of information about the location to consumer of information about the location. This is not so much an acceptance and distribution of roles and responsibilities as an inherent distribution of roles and responsibilities enabled by the way in which the Geocaching community is built on use of Web 2.0 technologies.

Informal learning opportunities when finding a Geocache begin with the consumption of information from within the Geocaching community, reading the cache description and downloading the coordinates. Further learning opportunities emerge as the Geocacher moves through the landscape, using the GPS to navigate, using maps, referring to the cache description and logs. Connected mobile and Web 2.0 technologies provide Geocachers with a medium through which to access and contribute relevant information and the GPS-mobile devices act as

tools to guide them through the landscape. These technologies are not used in isolation, but are deployed in combinations according to the preferences of the individual Geocachers.

a) *The Role of Technology*

To help clarify the role played by technology in the activity of Geocaching, participants were asked what type of GPS device they used. Table 1 shows that the majority of Geocachers surveyed in 2007 relied on a dedicated GPS device for Geocaching. However since that date GPS technology has been incorporated into a wider range PDAs and mobile phones so it is possible that this usage pattern will have changed.

Table 1 - GPS Technology Choices

Device	% (n=659)
A dedicated GPS device	93%
GPS PDA	5%
GPS mobile phone	0.5%
Other	1.5%

When asked about how they combined mobile technologies when out Geocaching, 93% (n=659) responded that they took one or more other mobile devices out with them. Devices included another GPS unit to help locate the cache and in case the first failed, a PDA to have the cache pages available for “*paperless caching*” (caching without a printed description) and laptop for road navigation in the car. Table 2 shows these responses.

Table 2 - Additional Devices taken Geocaching

Additional Devices	% (n=613)
PDA	83%
Mobile phone	78%
Camera	77%

MP3 player	11%
GPS	7%
Laptop	6%

The responses demonstrated a range of ways of using mobile technology to support Geocaching. It is interesting to note that although only 5% (n=659) of Geocachers relied on a PDA as their primary device for locating a Geocache, 83% (n=613) of those who took additional devices with them chose to take a PDA. The difference in the n-value reflects the fact that only 613 of respondents took extra devices with them when Geocaching. The low number of Geocachers who were prepared to rely on GPS-enabled PDAs as their main caching device could be because GPS-enabled PDAs were not very common when the survey was conducted in 2007, it could be because the GPS technology embedded in PDAs was not as accurate as that in dedicated GPS devices, or it may be because of usability issues.

Seeking, finding and logging Geocaches represents a regular contribution to the community. When a Geocacher finds a Geocache their experience of the cache location is guided by the description given by the Geocacher who hid the cache and informed by the accumulated narratives of other Geocachers who have previously found it. This connection is instantiated when the find is logged on the website. Thus, by simply going Geocaching, a Geocacher is contributing to the community by adding to the cache description and logs created by other Geocachers, building up the persistent digital narrative of location. However a stronger commitment is required to reach Stage 3 membership, and this is when a Geocacher makes the effort to hide one or more Geocaches for others to find, thereby making a significant contribution to the Geocaching community.

VII. STAGE 3 - COLLABORATOR

Stage 3 of Preece and Shneiderman's cycle of community membership is demonstrated, in the Geocaching community, when a Geocacher returns regularly and contributes to the physical community resources by hiding and maintaining one or more Geocaches, thereby creating detailed cache descriptions on the website that form the basis for the persistent digital narrative of location.

Creating even a small number of caches represents an ongoing level of commitment to the community as they require regular maintenance and effort. As between Stage 1, Reader and Stage 2, Contributor, progress to Stage 3, Collaborator, in which a Geocacher hides a cache for others to find, may be rapid. In their responses to the web survey, 82% of participants had hidden a Geocache and therefore progressed to Stage 3. Table 3 shows the number of caches hidden by the web survey respondents:

Table 3 - Caches Hidden

Caches Hidden	%(n=659)
0 caches	1%
1 - 50 caches	72%
51 - 100 caches	6%
>101 caches	3%
Did not respond	18%

Of the 72% (n=659) who had created between 1 and 50 caches, the majority, 58% had hidden between 1 and 10 caches and a further 24% had hidden between 11 and 20 caches. Hiding a Geocache for others to find demonstrates a commitment to the Geocaching community, and it is interesting to note that of the 132 participants who had less than 1 year's experience Geocaching, 58% had placed one or more Geocaches. This suggests that the Geocaching Community is a

successful one in which the transition through the Stages of Membership can be achieved within a relatively short timescale.

A. Creating and Hiding a Geocache

In order to create a Geocache, the Geocacher needs to collect together information about the location, double-check the coordinates to be sure that they provide an accurate guide and finally upload all this information using a webform to create the Geocache description. Placing a Geocache in a location is an invitation to other members of the Geocaching community to visit that spot. Often, caches are placed in places of outstanding natural beauty or historical significance, but they may also be placed in quiet “hidden corners” that might easily be overlooked. When asked *Do you hope that Geocachers seeking and finding your Geocache(s) would learn something in any way?* 71% (n=659) of web survey participants responded "yes". When asked what they hoped people finding their caches would learn, participants described introducing people to the history of an area, local geography and nature.

The learning opportunities when setting Geocaches involve researching the planned cache location in order to provide contextual detail for Geocachers trying to find the cache. Geocachers described how they would research information to place on the cache page:

[I learn] bits and bobs about areas and nature - I learn more setting my own caches as I research them to add info to the cache page (Survey response 213)

Doing a little research led me learn more about and appreciate the area myself. (Survey response 372)

1) Intentional Learning Opportunities

Any research undertaken in order to create a cache depends on the location and type of Geocache. For example, Earthcaches need geological or geographical knowledge:

I researched Sites of natural National importance, SAMs and SSSIs and selected two major

locations: Severn Bore (natural large wave on Severn Estuary under specific conditions) and Glaciers in Southern England. (Survey response 207)

I had to do research to find out why these areas existed so I could craft my pages to educate the visitors. I knew nothing going in, so everything I learned about karst geology and piedmonts is a direct result of these caches. (Survey response 71)

Setting traditional Geocaches or multi-caches may require some research into the history of an area: *I have begun researching ghost towns in Texas after visiting a cache located at one and as a result have placed caches in 20 ghost towns in my area to bring others to visit them. Am working on more currently. (Survey response 460)*

When creating a Geocache, external resources such as links to related websites or additional information obtained through research are brought into the community by the Geocacher hiding the cache. This results not only in the creation of new learning opportunities for other community members as they seek the cache, but in an altruistically motivated form of learning opportunity for the Geocache creator with the aim of creating learning opportunities for others.

2) Active Learning Opportunities

Creating a Geocache involves collecting together information about a particular location and creating a Geocache description webpage. Earthcaches involve creating webpages which describe some form of learning challenge for Geocachers to complete once at the Earthcache location in order to log the find. Creating a Geocache or an Earthcache incorporating a learning challenge for others often requires research into the area and several visits with a GPS unit to select the cache site and take accurate coordinate readings.

I'm putting an Earthcache together, covering a group of copper mines, I've read a couple of books on the topic and been out several times to identify remaining structures on the ground. Finding suitable learning activities is proving the hard bit to do. But I'm getting close. (Survey

response 281)

This is something that I am in the process of. I am trying to create one for Hunters Creek, which is a glacial-formed ravine. Do a water-hike down far enough, and you are looking up at steep shale cliffs on both sides. I am in hopes of getting this published this summer. In the meantime, it's a lot of research. (Survey response 307)

3) *Constructive Learning Opportunities*

According to Jonassen et al's definition, constructive learning involves routinely wrestling with new experiences, becoming experts at identifying and solving problems and striving to resolve any dissonance between what is observed and what is known, operating on a sincere desire to know [2]. Researching in order to set a Geocache, collecting accurate location coordinates, uploading them, an accurate description, images and guidelines represents a variety of constructive learning opportunities.

4) *Authentic Learning Opportunities*

Creating a Geocache involves similar real-world problem solving skills to seeking and finding a cache. Both require skills in using a GPS to identify location. However hiding a cache involves creativity and an element of cunning. Traditional caches need to be hidden in sensible places that will not be discovered by casual passers by. Multi-caches need the cache creator to use information from one location and translate it into the coordinates for the next location. Creating challenges and puzzles involve learning opportunities for both the cache creator and the cache hider, and selecting and describing interesting locations is an activity that involves interacting with real-world objects and places.

I always try to hide caches that have some meaning, something to learn or something to see. My best cache is hidden in a local cemetery where a B-25 bomber crashed during WWII on a training run to Florida. Its truly amazing how many locals are totally unaware that this event ever occurred in our little town. I get lots of positive feedback from the finders of this cache.

(Survey response 260)

5) Cooperative Learning Opportunities

Researching in order to place a Geocache seems at first glance like an individual learning activity. Participants mentioned using the internet as a research tool:

Did research on creating the geological history of the area. Lots of research from government websites. (Survey response 169)

Internet research, Edinburgh has a volcano in it very simple selection for an Earthcache, whilst researching that I found a mimetolith called the Grey Man of Merrick. I was so inspired about this face on a rock that I trekked out and found it and made that into an Earthcache.

(Survey response 151)

However this research is triggered by a wish to place a quality Geocache that will give pleasure and interest to those who seek it. Sharing information about a location is one of the ways of enhancing a Geocache. Creating a Geocache makes a significant contribution to the Geocaching community; the community wouldn't exist unless people were prepared to put the effort in to create and maintain Geocaches.

More explicit cooperative learning opportunities may occur when the Geocache creator is engaged in research that involves visiting the intended location for the Geocache, as illustrated by this quote from Case study 3 interview.

I went to the museum to do some research and met with the curator who was also a member of the local historical society. I explained to him all about Geocaching and he liked the idea and was happy to have the cache hidden in the garden at the front of the museum. He spoke about the town and described the places of interest that could be found. I then visited each of these sites and devised a safe walk around the town that took in some of the most interesting places. The historical society had erected information plaques around the town and I decided to make

each waypoint rely on the collection of data from these plaques.

Sometimes, the cache creator already possessed the subject-specific knowledge, yet worked as part of a group in order to create the Earthcaches for others:

I did a degree in geology so I was very switched on to Earthcaches. I was part of the team who established the first Earthcache in the UK. This was at a place that I knew about from my geology studies and thought it would be good for other people to discover it too. I put together some questions which would hopefully make the cachers do a bit of web research and learn a bit more than they could from just a visit to the site. (Survey response 582)

This quote does not mention any learning opportunities for the cache-creator, but the involvement of a team who "*established the first Earthcache in the UK*" suggests that there were cooperative learning opportunities available to others who might learn more about geology from survey respondent 582.

This example illustrates how the learning opportunities encountered when hiding a Geocache as part of a group, as described by survey respondent 582, conform readily to Jonassen et al's definition of cooperative learning with technology. However a more typical Geocache created by an individual appears to present fewer cooperative learning opportunities.

The desire to give something back to the community, leading to deliberate informal learning efforts in a range of subjects reveals a new angle on the relationship between community membership and informal learning opportunities.

Caches have inspired me in two ways. First, in the clever methods of hiding and thereby to emulate the hide. More importantly, caches I have found in neat parks or locations I otherwise would not have visited inspired me to hide my cache in a place that was scenic and historic. (Survey response 248)

I've done research on the background of ghost towns I discovered while caching, and often research areas in order to hide a cache there so I can educate others as well. (Survey response 246)

Creating a Geocache involves the individual (or team) choosing a location that has not been used in another cache and bringing together a range of external information resources to create a location-specific Geocache or Earthcache description. This description is then placed on the Geocaching website and made available to other Geocachers.

This seemingly altruistic goal of learning in order to create stimulating and engaging learning opportunities for others is a facet of informal learning that is closely connected to community membership and cooperative learning.

VIII. STAGE 4 - LEADER

Preece and Shneiderman [18] characterise the leaders of online communities as typically contributing the largest number of comments and being the most active online. The activity of Geocaching connects Geocachers with each other through the Cache descriptions and find logs of the locations that they visit. However a more direct form of communication can take place through the online web forums. Table 4 illustrates the web forum use of the survey respondents.

Table 4 - Web Forum Use

Geocaching Forum Use (n=659)	%
Frequently read and post messages	22%
Occasionally read and post messages	58%
Read messages but don't post	16%
Don't use the forums particularly	4%

Based on frequency of forum contributions, it appears as though 22% (n=659) of web survey respondents may have reached Stage 4 of community membership by contributing frequently to the forums. However the Geocaching community, although co-coordinated online, has a strong physical element which is reflected in the characteristics of the leadership opportunities it presents. Certainly, leaders may be prolific contributors to the Geocaching web forums. However they are also likely to be active in other aspects of Geocaching. For example, by finding and logging many Geocaches as well as hiding Geocaches for others to find, by coordinating the efforts of others by organising or coordinating event caches (where Geocachers meet up) and by taking responsibility for organisational functions or Geocaching Events.

There are a number of ways that Geocachers can meet up. Two Geocachers or Geocaching groups may arrange to meet in order to seek a cache together. Alternatively, a Geocaching event, known as an "Event Cache" may be organised. When asked whether they had ever attended an organised Geocaching Event, 72% (n=659) of respondents replied that they had. Geocaching events are organised by Geocachers for Geocachers. Event Cache creation was therefore not selected as a characteristics of Stage 4, Leadership within the Geocaching community because event caches are widespread within the community and not significant enough to be representative of a separate stage of membership. Instead, Leadership characteristics were sought that more closely matched Preece and Shneiderman's definition of Stage 4 which included "*promoting participation, mentoring novices, setting and upholding policies*" [2].

One of the case studies, Case study 1, was involved in a regional sub-group, the Geocaching Association of Great Britain (GAGB). He helped set up the GAGB with to provide a focal point for public liaison and an elected body to represent the interests and promote the growth of UK Geocaching, negotiation permission to place caches with organisations such as the Forestry

Commission, the Woodland Trust and the National Trust. They also liaise with organisations such as the Metropolitan police regarding caches placed near sensitive areas in London. Case study 1 is the lead negotiator with the landowners and remains a member of the GAGB organising committee, playing an important role in supporting UK Geocaching. This matches Preece and Shneiderman's definition of Stage 4.

According to Preece and Shneiderman's criteria "*Leadership is a higher calling to which only a small fraction of readers, contributors and collaborators aspire. <...> They want to contribute to something meaningful that goes beyond their personal gain*" [2]. Helping to set up the GAGB and undertaking complex negotiations with landowners in order to enable Geocachers to place caches in more places demonstrates a level of commitment over and above that demonstrated in Stages 1, 2 and 3 of community membership.

However fewer community members reach Stage 4 and, therefore the learning opportunities presented by the Leadership stage may vary widely. It is clear that learning opportunities will be present, in this case, opportunities to develop negotiation and organisational skills seem likely. However it is not possible to say with any certainty that these learning opportunities are characteristic of all Stage 4 members.

IX. CONCLUSION

This research described in this paper has provided substantial data about how people are using mobile and social technologies to link up and learn together both online and offline, presenting evidence of a working online community that validates and extends existing community models. The findings support Preece and Shneiderman's [18] four stage model of community membership, illustrating each stage with evidence of engagement in community practices and uncovering informal learning opportunities that increased as the Geocacher progressed through

the stages.

The informal learning opportunities identified during the membership trajectory of a Geocacher were classified according to Jonassen et al's five attributes of meaningful learning with technology; Active, Constructive, Intentional, Authentic and Cooperative [2]. However, informal learning opportunities were identified that exhibited characteristics that did not fully conform to these attributes. These were unintentional informal learning, where the opportunity to learn arises out of the experience of Geocaching and implicit cooperation in the creation of shared resources supported by the collaborative affordances of Web 2.0 technologies and inherent in the design of the activity of Geocaching. This suggests that the Intentional and Cooperative attributes of meaningful learning with technology need to be extended to cater for informal learning with technology.

One interesting finding was that although learning opportunities were integral to community membership, learning was not the main reason people joined the community or started Geocaching. Despite this lack of original intention to learn, the majority (89% n=659) felt that informal learning emerged as an important outcome of community membership. New members learned skills and cultural practices in order to become active Geocachers, and more experienced Geocachers learned both through sharing in experiences of location, and through creating engaging location-based experiences for others. The enhanced experiences of location motivated community members to increased participation in community activities (hiding Geocaches for others) through a desire to give something back to the community, or reciprocate in some way, thereby moving further along the stages of community membership [18] and sustaining a dynamic and active community.

The Geocaching community has devised novel ways to use technology to augment perceptions

of location by combining the affordances of mobile and Web 2.0 technologies, allowing people to focus on the creation and sharing of representations of place that developed over time into a persistent digital narrative of location. These narratives form an important community resource and mobile technologies enabled individuals to participate in and contribute to this narrative by taking the power of technology out into the field. The interconnected nature of the social technologies used by the Geocaching community support the creation and maintenance of links between people and location through the network of cache descriptions and find logs. This allows individual Geocachers to build reputation and helps sustain a growing and dynamic distributed online community.

The focus on collaborative activities and creative products that underpins Web 2.0 technologies has been deployed by Geocaching community members to create shared resources and support community activities. Roles and responsibilities shift as Geocachers alternate between consuming information as they seek the Geocache guided by the cache description, and contributing information as they enhance the locational resource from their own experiences.

The research described in this paper has demonstrated the impact of mobile and Web 2.0 technologies on informal learning by looking at a blended online community, the Geocachers. This community use mobile and social technologies to blur the boundaries between the virtual spaces of the internet and the physical spaces that surround them, creating persistent digital narratives of location that provide a temporal record of place that acts as a resource for others. Participation in the community activities, initially by using shared resources to seek out Geocaches, and subsequently by contributing to the community resources by hiding new Geocaches for others to find has revealed how mobile and Web 2.0 technologies can be used to create engaging and meaningful learning opportunities that focus on physical location. This has

contributed to our understanding of informal learning in a modern technological context by providing evidence of how informal learning practices are supported by advances in mobile and Web 2.0 technologies, and suggests ways we might use these technologies to enhance our formal learning practices to incorporate a Web 2.0 approach to knowledge creation and sharing.

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