ABSTRACT
In this paper, we explore citizen science as a method for user engagement. We take as a starting point the user engagement model of O’Brien and Toms and explore citizen science within the user engagement paradigm, being motivated mainly by the potential for a wider uptake in the digital cultural heritage domain. We concentrate on the identification of user needs; which could aid the planning of citizen science initiatives and their implementation. Looking at typical activities identified so far in research on citizen science and crowdsourcing, we illustrate that these typical activities need further refinement to link them to the typical user engagement stages. Analyzing user engagement and citizen science together would be of benefit for strengthening citizen science projects and providing more detailed guidance for involved stakeholders. We discuss how this is being done within a pilot on placenames in rural Ireland currently being implemented within the Civic Epistemologies project. This pilot represents a novel experiment in bridging an engagement model with a practical citizen science activity in the digital cultural heritage domain.

Categories and Subject Descriptors
H.3.7 [Digital Libraries]: User issues

General Terms
Human Factors, Experimentation.

Keywords
Digital cultural heritage, citizen science, crowdsourcing, engagement, user studies

1. INTRODUCTION
1.1 Citizen Science and the Role of Civic Epistemologies project
Citizen science is enjoying increasing popularity and is becoming a new outlet for people who are not professionally trained to be researchers, but who are willing to contribute to a wide range of research activities. Modern technological environments, enabled in particular by the advancement of mobile technologies and social media, allow for innovative ways to involve vast groups of such voluntary researchers in different ways. Nevertheless, it is important to note that citizen science is not a modern phenomenon—it was particularly prominent during the 19th century.

Currently citizen science is very popular in the sciences but is not equally prominent in the domains of Humanities, Arts and Digital Cultural Heritage [3]. In order to understand how it could be used more actively in these areas, the Civic Epistemologies project [2] addresses:

1) How to increase the use of citizen science within the digital cultural heritage context. This can be done understanding better the current contexts of use, the patterns of user engagement and the stumbling blocks for various types of stakeholders involved in citizen science. In other ways this requires to identify the stakeholders relevant to citizen science, and to capture their requirements. This knowledge can also allow for building better targeted awareness campaigns, and for setting up realistic indicators for the outcomes of new citizen science initiatives;

2) What available e-Infrastructure components facilitate citizen science and what tools are currently missing.

While the availability of technical infrastructures is one of the key components and identifying gaps in provision is one of the essential drivers for spreading wider citizen science in digital cultural heritage, the other key success factor is the sound understanding of the user needs. Within the Civic Epistemologies project the main interest is on the needs and expectations of key stakeholders: memory institutions, citizen activists, policy makers, as well as citizen scientists themselves. The needs of these different stakeholders are being captured by a combination of desk research, focus groups and an online survey presented in detail in the project’s deliverables D2.1 and D2.2 [2]. However, this paper elaborates on aspects that complement the direct user studies with insights from the user experience design and user engagement domains.

1.2 User Experience Design and User Engagement within the Citizen Science Context

The process of human-centered design for interactive systems, to which citizen science belongs, is summarized within this diagram (see Figure 1) from the international standard on ergonomics of human-system interaction ISO 9241-210 [4].

While memory institutions (or any other institution implementing a citizen science project) most typically would not be tasked to develop new interfaces, they would have to make decisions on tools they would be using, training/involving users and, in this case, the stages of “understanding specific context” and evaluating the outcomes would be of major importance for the success of their project.
The focus groups organized by the Civic Epistemologies project (see D2.1, [2]) identified that the policy makers from the cultural heritage domain view the major benefit from using citizen science as improved user engagement, rather than saving money and/or staff time. This inspired us to look deeper into the peculiarities of user engagement. As defined by Heather O’Brien and Elaine Toms [6]: “Engagement is a category of user experience characterized by attributes of challenge, positive affect, endurability, aesthetic and sensory appeal, attention, feedback, variety/novelty, inter-activity, and perceived user control.” O’Brien and Toms propose an engagement model which explores four steps in the engagement process, namely “the point of engagement (engagement is initiated), period of engagement, disengagement, and reengagement” [6: p.943]. We will use this model to first of all map various types of activities within the citizen science domain to engagement stages in Section 2, and then present a pilot around citizen science applied for rural archeology in Ireland in Section 3. Finally we provide some conclusions and directions for future work in Section 4.

2. USER ACTIVITIES IN CITIZEN SCIENCE AND CROWDSOURCING

2.1 User Activities in Citizen Science Activities

Whilst we were not able to identify larger-scale surveys on citizen science applications in cultural heritage institutions, Angela Wiggins and Steven Crowston from the Syracuse University, USA did do relevant work systematically. Wiggins and Crowston [8], [9] summarize results from 63 surveys, completed as a result of 840 emailed requests for participation, which were used to create 128 project profiles. The range of activities to which unprofessional researchers contribute in citizen-science projects include, as suggested by Wiggins and Crowston [8], the following:

1) Define question 
2) Gather information 
3) Develop hypothesis 
4) Design study 
5) Data collection 
6) Analyze sample 
7) Analyze data 
8) Interpret data 
9) Draw conclusions 
10) Disseminate results 
11) Discuss results and ask new questions

Those activities are not aligned to engagement patterns by Wiggins and Crowston, but all of them would naturally be linked to the stages of establishing the point of engagement and the process of active contribution. To be successful as forms of engagement they need to be appealing to the unprofessional researchers, who should find them suitably stimulating to motivate their ongoing engagement in the citizen science project.

In a further study, Wiggins and Crowston [10], revisit the granularity of their previous classification of activities and arrive at the following structure of activities: “The main research activities open to participation in the responding projects were observation, data entry, and species identification. This reflects the fact that most of the responding projects focused on data collection, frequently for observational data. The next most common tasks were measurement, site selection and/or description, and photography. These tasks are specific to certain types of field-based participation that can also include observation.

Additional activities reported by respondents were diverse, primarily scientific tasks related to specific project requirements, and occasionally tasks related to stewardship and communication, identifying three main groups of tasks:

- **Scientific tasks**
  - Posing new questions, literature reviews, paper writing, etc.
  - Videography
  - Monitoring
  - Insect rearing
  - Identifying animal tracks
  - Creating maps

- **Stewardship**
  - Organization and landowner coordination
  - Manual labor, habitat construction, shell recycling

- **Communication**
  - Communication with other participants and with scientists
  - Sharing observations and findings at meetings of related groups.”

While this further insight into activities adds a richer fabric of citizens’ roles, a particularly interesting development from the engagement perspective is adding communications as an activity; this is one aspect that is indeed relevant to all stages of engagement discussed in Section 1.2. However, communication for the various stages needs careful planning within a project lifespan and a moderator who would be able to keep the dialogue going.

2.2 User Activities in Crowdsourcing in the Cultural Heritage Domain

Wiggins and Crowston provide a most useful insight into activities across citizen science projects in general. Identifying the activities that are most relevant within the cultural heritage domain is still an exploratory area; evidence of work that is relevant can be gathered from research addressing crowdsourcing. Notwithstanding that crowdsourcing does not necessarily aim to engage citizens in research projects and that such initiatives are
not normally led by academics, it is one of the major techniques employed in citizen science initiatives. Thus, the experiences from crowdsourcing can provide helpful pointers for designing citizen science activities.

The most popular classification of typologies of crowdsourcing projects in the memory institutions domain has been made by Johan Oomen and Laura Aroyo [7]. They suggest six different typologies of projects; each one linked to a different kind of study, and respectively tasks:

1. **Correction and transcription** – the citizen is given access to a database (usually a text-based database like scanned manuscripts) and then she gets the task of transcribing or making corrections to the text which was already transcribed electronically via a computer program;

2. **Contextualization** – citizens submit data such as letters, stories, films, photographs or other documentary material in order to gather a meaningful context;

3. **Complementing collection** – citizens are asked to add data into databases with the ultimate aim of completing them or making the collection grow;

4. **Classification** – citizens tag the data, or label it, in order to easily group similar data and make the information more easily retrievable in the future;

5. **Co-curation** – this practice occurs mostly with projects involving the aesthetic arts. Citizens interact with institutions and voice their opinions when it comes to choosing articles or items for publication;

6. **Crowdfunding** – citizens are asked to gather together money and/or resources in order to support efforts initiated by others.

A different approach is proposed by Tobias Blanke and Mark Hedges [1] within the context of Humanities e-Science; while their paper is not focused on citizen science it identifies some typical scenarios and illustrates how all of them are integrating a number of scholarly primitives, namely collecting, discovering, comparing, delivering, and collaborating. While it would require an additional study to justify the use of the same or different set of primitives in citizen science, this is an approach that introduces different levels of granularity with the primitives as the smallest building blocks of more complex activities.

These types of activities illustrate aims but again further research is needed to link them to engagement.

3. **PILOT ON ARCHEOLOGY IN RURAL IRELAND**

3.1 **Vision**

We have all heard stories from our elderly relatives and neighbors that relate to our local heritage and landscape. Some of this information is passed on to the next generation but sadly most of it is lost with the passing of the elderly person, and is gone forever. In Ireland, for example, we have family names (also known as micro-names) for local fields and other features in our rural landscape. This information is a significant part of our local heritage, yet often it is not documented anywhere, not on any document or map, only in the memories of people living in the area.

The overarching aim of the pilot is to assess whether socio-technical approaches can leverage the ‘cognitive surplus’ and harness the ‘wisdom of the crowd’ to overcome a digital and intergenerational experience divide. Some of the questions that arise in this context are as follows. Could young citizens (specifically teenagers) be engaged to record, and document this heritage before it disappears forever? Could citizen research on the ethnographic aspects of placenames create a context for generating a rich collection of digital humanities heritage recordings including first-hand accounts of place-based memories with social descriptions about the unique ordinary lives of local people, whilst also facilitating meaningful personal intergenerational exchanges? What expertise would be needed and which freely available applications and tools could the teenagers use on their own devices? Would citizen volunteers be interested in pursuing this idea? What are the significant social and cultural factors for intergenerational research in this pilot project?

3.2 **Engagement of citizen volunteers**

We engaged with two different groups of citizens: teenagers, aged between fifteen and seventeen years old, and senior citizens. Obtaining the support of schools and Transition Year teacher coordinators was a prerequisite to accessing the teenagers. We offered four non-paid work experience placements for teenagers seeking to form a dedicated group with a mix of qualities such as: experience and familiarity with exploring new digital technologies; good organizational and planning skills, excellent social skills and emotional intelligence, good design and presentation skills, an interest in careers in cultural heritage, social science, media, research, or digital technologies, and interest or interest in working with older people and technology. Two of the four schools we contacted invited their students to apply. Others indicated they would be interested in the results.

These teenagers are digital natives who report that they and their peers are immersed in digital entertainment, and online information. They record and facilitate their social lives through social networking services.

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1 The Transition Year (TY) is a one-year programme that forms the first year of a three-year senior cycle in many Irish schools. It is designed to act as a bridge between the Junior Certificate and Leaving Certificate programmes. It is available to all second level schools and currently approximately 75% of schools offer the programme. Transition Year is optional for students in most schools.
We also engaged with senior representatives to ensure their voice was heard in the design of the toolkit. The senior citizens, who elected to participate, were from a local family heritage group in Tramore, Co Waterford. This group meets weekly in a local community center, to work together on local heritage projects. A historian and community facilitator is one of the groups founders, and she has been recording stories and doing collaborative research with this group for over two years, so for the most part this group have an established interest in heritage subjects and are experienced in taking part in both audio and video recordings.

Planning engagement with volunteers was uncertain, and dependent on fitting in with the volunteers timetables. Ethical issues were a primary concern as both groups are vulnerable. Consent forms were drawn up with consideration of the European Responsible Research Innovation (RRI) guidelines, and all aspects. Both written and verbal consent was sought and recorded. Participants knew they could opt out at any stage. Ethical issues related to supervision of minors outside of school premises in a pre-agreed working environment and ensuring all participants felt empowered. While personal accounts were shared it was also necessary to ensure the research was conducted respectfully. It was necessary to ensure work experience was suitable, supervised and beneficial to the individual students involved – additional talks and experiences were also organized. The involvement of a well-known local third level educational institution (Waterford Institute of Technology) lent the project credibility and facilitated engagement with both volunteer citizens and volunteer experts.

This pilot adopted a participatory co-design approach working with the student group to define a methodology for students to record ethnographic information about placenames and place-based oral histories. This citizen-led approach democratizes the means of local place-based cultural production and consumption, empowering those who participate and in this way will be part of defining a best practice for further expansion.

Six students, one girl and five boys, each spent a week or two, over a period of three weeks in November 2014, working on this project every day in the Waterford Institute of Technology in collaboration with the pilot coordinator, a professional User Experience (UX) researcher. During this time they: conducted desk-research; developed communications materials such as leaflets and press releases; conducted interviews with experts; reviewed and selected recording, editing and presentation technologies, organized and facilitated a participatory meeting as a quasi experiment; made audio recordings with senior citizens and relatives; edited and curated those recordings; blogged about their experience; designed a logo; and developed a website with audio and map plugins.

Socio-cultural records of ordinary life in previous generations are thin—haphazard often scarce, reliant on official newspaper accounts, archives, and occasional family photographs; senior citizens’ personal recollections are a valuable cultural resource. In contrast, many teenagers of 2015 make thick cultural records—recording and sharing countless moments through photos, video, text on their phones, tablets or computers everyday; teenagers digital skills are a valuable culture-recording resource in society. Place-based intangible cultural heritage, as evident in placenames, oral history and stories of place, is a significant factor common across all generations, and this is one reason why it has been selected as a literally common ground on which to center intergenerational cultural exchanges in our civic epistemologies pilot study.

### 3.3 Interviews with experts

The student group sought the advice of several professional experts on this particular place based cultural heritage. The students conducted a telephone interviews with Dr Aengus Finnegan, a placenames researcher working in FIONTAR in Dublin City University on Loganim.ie, the official web application for placenames created in cooperation with the Placenames Committee and the Irish Department of Arts, Heritage and the Gaeltacht, and also with Risteard Ua Croinin, the Architectural Conservation Officer from Clare County Council, Ireland. Both these experts outlined a similar methodology for placenames, involving initial library-based research, to become familiar with local historical maps, and boundaries before referencing more modern ordinance survey maps for fieldwork. They described the research required as “detective work,” in terms of finding and identifying the senior knowledge holders to be interviewed within a local community—who have special placenames information, but may not themselves realize it. Both interviews emphasized the importance of acquiring audio and phonetic recordings of the local spoken pronunciations of placenames, as this can be significant in deciding the linguistic derivation and making sense. Cuimhneamh an Chlár2 (Clare Memories), a community-based voluntary oral history group, also provided practical advice for quality audio recording and editing, and ongoing support throughout the project.

One of the founders of the Tramore Local heritage group, Dr Maxine Keoghan, a community worker and historian, also met with the teenagers prior to agreeing to broker an introduction to seniors in the group. She advised the student group about empowerment, the importance of setting-up a well prepared physical space with the right number of seats, the cultural significance of tea and hospitality, preparing and practicing questions in advance, and managing consent forms. She shared insights about her own recording experiences and the ‘out of control’ feeling when an interview goes tangentially completely off topic but can yield ‘nuggets of gold.’

### 3.4 Participatory Meeting

A participatory meeting was held, over three hours, on 5 November 2014 in the Waterford Institute of Technology. This allowed both volunteer citizen groups to experience intergenerational interviews, explore possible methodologies, gather sample recordings, and discuss emergent issues. The participants included: three students, two seniors, one heritage group facilitator, and the pilot coordinator. Tea and sandwiches were offered to show hospitality and create a welcoming atmosphere. The meeting was organized in two halves for a quasi experiment to explore whether an interviewing methodology using stimuli, or not, was more appropriate. Firstly, one student asked a set of questions, another managed the recording device, and a third took notes for a recorded interview with all participants. Then later, students asked questions about a pre-prepared selection of local area on historical maps from the Ordnance Survey Ireland web application, and photographs from the Waterford County Museum.

The ambience was friendly and enthusiastic. Placenames, were not the particular focus during the meeting, rather the participants discussed a wide variety of subjects and uncovered a wealth of

2 [http://www.clarememories.ie/](http://www.clarememories.ie/)
stories about their locality. As a result the participants decided that to be inclusive and suitable for broad use in schools the proposed heritage should be extended to include recordings of oral history about places. Whilst the participants were strangers beforehand, all agreed that for broader adoption the safest approach would be to suggest students interview a family member. Some students went on to do this and reported that it was a meaningful and interesting experience they would not otherwise have had.

In the days following the interviews, the students found the editing and curating aspects challenging. They struggled to decide which were the most interesting and important clips for export and publication on the web. They did not have enough time to fully reflect and worried about the audio quality. They were concerned to be respectful to the interviews, especially given the trust relationship they had built with the interviewees and the responsibility this engendered. We believe that this indicates the need for continued professional humanities researchers guidance and support for people engaging in cultural heritage citizen science activities.

3.5 Intergenerational Digital Toolkit

The intergeneration digital toolkit developed to record heritage in the Civic Epistemologies project pilot consists of a website designed and developed by the students and a suite of free widely available applications for use on smartphones and laptops. Recordings were using internal voice recorder on a Samsung Galaxy android smart phone. Audacity³ was used to edit the audio files. Soundcloud⁴ was used to store and share the published audio files. Wordpress⁵ was used to develop the website. Adobe Creative Suite⁶ was used to design graphics and handouts. Various Wordpress plugins were integrated to include maps with embedded recordings on the website.

The website showcases some of the audio recordings made during the participatory meeting as reference examples, along with further recordings made by the students with their relatives. It offers distilled simplified methodologies for recording placenames and oral histories, along with a blog documenting their experience in working on the project. It is integrated with social media plugins and maps.

The aim is that this toolkit would both present their work and invite other teenagers and transition year students to participate in similar studies recording heritage. Is it suitable for use within a class in a school environment but could also be used by individuals or other clubs outside of school.

We did not elect to further publicize the toolkit at this stage, as we do not have the resources to manage moderating and editing the submissions. We believe the value in this citizen led approach is that the recording and digitization of cultural heritage creates an opportunity for face-to-face intergenerational exchange that might not otherwise occur, and that has a transformative personal value for the participants beyond the gathering of cultural repositories.

3.6 Engagement for Recording Heritage

Recognizing the major stages of user engagement, according to O’Brien and Toms [6] we can summarize the following principles with reference to the project pilot.

Point of engagement

“Initiated by the aesthetic appeal or novel presentation of the interface, the users’ motivations and interests, and users’ ability and desire to be situated in the interaction and to perceive that there is sufficient time to use the application.” [6]

Within the pilot study, we sought to develop an intergenerational digital toolkit that included informative inviting and attractive interfaces, along with highly usable easily learned applications, which could be used as a project support in schools. We have engaged with the primary communities directly and extensively, to try to ensure that this toolkit for recording heritage meets the needs of schools, students, and seniors. We suggest that research and preparation, editing and recording activities could be integrated into school-related projects to address the time aspect.

Sustaining engagement and re-engagement

“Engagement is sustained when users are able to maintain their attention and interest in the application, and is characterized by positive emotions. Users want to customize the interface to meet their needs and receive appropriate and timely feedback from the application. In addition, they want to lose their perception of time and others during some interactions, but keep their awareness of others in cases where engagement is enhanced by social interaction.” [6]

The co-design immersive approach successfully engaged the students who worked on the development of the toolkit. Some opted to continue to work on the project for an additional week. The social engagement aspects relate to the intra-group teamwork in research and making design decisions, as well as the rewarding external connections developed through conducting the recording heritage interviews. The social networking aspect is augmented through online publication of interview segments, listening to snippets published on the website integration of social sharing, and blogging about the experience. Editing whilst time-consuming is absorbing and promotes reflection. Retaining ownership and responsibility for the recordings supports development of cultural heritage stewardship towards the recordings. There is further potential to highlight the most interesting contributions both on the website and in school contexts.

Integration of the results into the archives of local libraries, and archives whilst beyond the scope for this pilot would be recommended for sustaining citizen powered cultural heritage recording and validating the work within the wider community. In this respect it is considered that issues related to formalizing norms of attribution and valuation of all the citizen participants, groups, and verification of stories, in traditionally professional publications, is work that remains to be done.

Disengagement

“Users disengage for many reasons such as the usability of the technology (i.e., challenge and interactivity), and distractions in their environments. This stage, depending on the outcome, resulted in either positive or negative emotions.” [6]

The nature of the intergenerational pilot is designed for one intensive contribution for teenagers and seniors rather than repeated engagement, except in the case of schools and experts.

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³ http://sourceforge.net/projects/audacity/
⁴ https://soundcloud.com/
⁵ https://wordpress.org/
whose engagement would need to be ongoing. We propose that regularly updates on websites showcasing new contributions, blogs sharing participatory experiences, combined with social media campaigns could facilitate repeated use and integration in school context. We also propose to investigate the reasons for schools, students and seniors to not engage or disengage.

During our pilot we also approached some schools and senior groups, who chose not to engage. The reason given was that they either felt they didn’t have the required time to prepare engagement or the appropriate local knowledge – particularly for placenames. We propose to try to avoid disengagement by broadening the subject matter to make it more inclusive – so that everyone who wants to can contribute, involving the citizen scientists in decision making with regard to editing and curating, empowering them to tell and share their stories. The more particular discovery of unique micro placenames can still be gathered in the case where interviewees are likely to be knowledgeable about the subject, but including place-based stories, and folklore enables the intergenerational toolkit to be more adaptable for widespread adoption.

4. CONCLUSIONS

This paper explored the scientific evidence on identified activities in citizen science projects and argued that further research is needed to link better the knowledge of activities with dimensions of user engagement. We used the model of user engagement of O’Brien and Toms and the stages of engagement in particular as a basis of the engagement-driven thinking within a pilot on placenames in rural Ireland, which is currently being implemented within the Civic Epistemologies project.

Through our pilot we have learned that participating in cultural history recording projects assists seniors to appreciate the value and worth of their own personal recollections. Learning about how previous generations lived in one’s local area directly through listening and conversations is a way to bring history alive, make it immediately relevant and enable young people to see their own position and potential in a longer view. Sharing stories and knowledge about place and language through cultural heritage research gives civic participants access to the wider historical networks of memory; deepening cultural connections to the natural and built landscape, whilst also building social capital within communities.

Although this paper provides some initial insights in linking stages of engagement with a specific citizen science activity, further analysis and evidence gathered to map these stages from ongoing projects would help to understand better the patterns of engagement and to establish stronger strategies for successful use of citizen science in the digital heritage domain.

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