Local Communities as Infrastructure for Place-Based Mobile Learning

Dan Richardson

Supervisor: Dr Ahmed Kharrufa

School of Computing Science
Newcastle University

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Abstract

The last decade has seen a significant reconfiguration of the UK's public services through policies of austerity. Severe funding cuts have been made to many local councils, resulting in various services—such as the upkeep of local parks, and educational activities within them—to be cut from some authorities' funding altogether, with their upkeep instead relying upon volunteerism or charges. Coinciding with an increase in the use of mobile technologies in schools, stakeholder groups are frequently also turning to them in an effort to promote the places they care for: attempting to engage with new audiences and promote the value of place to younger generations.

This thesis explores the design space for mobile learning platforms which harness places and communities as resources for both formal and informal learning, and how such technologies can be used by stakeholders to share their knowledge and further their own agendas. This design space is then further explored through the design, development and evaluation of OurPlace—a mobile learning platform consisting of Android and iOS applications and a supplementary website. Through multiple engagements, OurPlace was shown to support community members, teachers and learners in creating, sharing and engaging with place-based mobile learning activities through seamless learning experiences. To further investigate how such mobile learning technologies and local resources could be effectively used within formal education, this work also proposes a framework for 'project-based mobile learning', applying and evaluating this framework using OurPlace in three different schools and a summer school of Travelling Showchildren, working within the unique constraints of each.

Through a design-based research approach, this project combines findings of longitudinal observational studies with volunteer community groups and a mix of long and short-term case studies with schools to contribute: implications for designing digital platforms which harness places' existing social infrastructures as resources for civic learning; OurPlace, a platform designed to harness these resources; and the introduction and demonstration of a generalisable framework for structuring the use of such mobile learning technologies within project-based learning, along with recommendations for its re-configuration in response to contextual constraints.

Declaration

I hereby declare that except where specific reference is made to the work of others, the contents of this dissertation are original and have not been submitted in whole or in part for consideration for any other degree or qualification in this, or any other university. This dissertation is my own work and contains nothing which is the outcome of work done in collaboration with others, except as specified in the text and Acknowledgements.

Dan Richardson
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Dedication

This thesis would not have been possible without my many colleagues who contributed towards facilitating workshops, testing apps, and writing papers. Special thanks go to my supervisor, Dr Ahmed Kharrufa: who gave consistently valuable feedback throughout the research and writing processes, and was my partner in crime in spending too much money on speakers and camera gear. Particular thanks also go to the remaining co-authors on the papers which came out of this thesis: Dr Clara Crivellaro, Dr Kyle Montague, Dr Pradthana Jarusriboonchai, and Professor Patrick Olivier; all of whom have their mucky fingerprints in this document. My thanks also go to my examiners Dr Vasilis Vlachokyriakos and Professor Yvonne Rogers, who together make up half of this document's total readership.

To the staff and students of Open Lab, past and present: thanks for putting up with me, and creating such a weird, welcoming and unforgettable workplace. Particular love goes to the education group (Ahmed, Megan, the Colins, Dan, Rebecca, Raghda, Serdar, Vidya, Anna), my placement pals (Jay, Rosie, Carlos), the Blighttown Brigade (James, Jazz, Dan, Kellie), and all of my Cohort 2 family.

I would also like to thank my collaborators and friends in both the Heritage Forum and in schools across the North of England, whose trust, patience and imagination made OurPlace possible.

Finally, many thanks and love go to my family, who provide endless support and encouragement, and to my loving partner Connie, who (despite presumably being sick of me) I've somehow corrupted into entering a career as a developer and managed to drag across the world with me.

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Chapter 1. Introduction

'An empathetic and compassionate understanding of the worlds beyond our own places may best be grounded in a love of a particular place to which I myself belong. In this way, we may recognize that what we need in our everyday world has parallels in the worlds of others.'

Edward Relph

1.1. Research Motivation and Context

Smartphones have reached the point of ubiquity in the UK: with an estimated 82% of the total population (around 55 million people) owning a smartphone in 2018, the country has one of the highest levels of smartphone penetration in the world (Wikipedia, 2020). With this comes a similar level of ubiquity of access to information—thanks to mobile access to the Internet, people are now able to create and consume multimedia content on-demand, regardless of time or location.

This has presented a wealth of new opportunities for computer-assisted learning and further popularised the concept of 'mobile learning', which Crompton et al. define as: '*learning across multiple contexts, through social and content interactions using personal electronic devices*' (Crompton, 2013). As mobile devices have gained in ubiquity, functionality and computing power, the popularity and sophistication of mobile learning applications and websites has increased in turn. Hardware features such as GPS and camera systems are being used to deliver educational content such as augmented reality experiences (Google, 2020) and interactive quizzes that adapt to the learner's physical location (Giemza et al., 2013), enabling cross-media learning within authentic environments. The increasing availability of these rich learning experiences on tablet-sized devices has also led to the adoption of mobile learning within UK schools, with nearly half being expected to have one tablet per

child within the next few years (British Educational Suppliers Association, 2015). However, due to the need for advanced technical knowledge, the means to create bespoke versions of these rich mobile learning experiences has remained out of reach for many teachers and students.

This research also takes place against a backdrop of political and financial uncertainty for much of the UK's public sector. The combination of significant austerity measures on local government budgets and a renewed focus on localism has led many local authorities to increasingly rely upon volunteerism, in the stead of properly funding the maintenance of public spaces such as parks. As a result, community spaces are being increasingly cared for by groups of volunteer stakeholders. However, as volunteering is more attractive to the time-rich, these volunteer groups are largely made up of retirees, with young adults and those living in lower socio-economic groups being less likely to volunteer (National Council for Voluntary Organisations, 2019). With the knowledge that these spaces rely on the ongoing support of volunteer stakeholders, volunteers are continuously looking at ways in which they can engage younger audiences in an effort to share their knowledge, highlight their perceived value of place, and increase their groups' long-term sustainability.

With the increasing prevalence of mobile devices, these stakeholder groups are frequently turning to online digital presences, through mediums such as social media platforms and mobile applications (inspired by the success of platforms such as *Pokémon Go*). However, the older demographics that constitute the majority of these groups typically have less experience and confidence with using digital technologies. This lack of digital literacy has meant these groups often struggle to effectively create and maintain group websites and social media pages, and, like teachers and students, lack the knowledge and resources necessary for creating bespoke mobile applications. As a result, these volunteer stakeholders frequently struggle to create engaging digital solutions through which to share their knowledge, passions and values with new audiences.

This thesis explores the design space for mobile platforms which support users in the creation of bespoke mobile learning activities which harness places and communities as learning resources—both in the formal education context of schools, and in the more informal context of community-generated mobile learning experiences. Of particular interest is how such technologies could be used by these community stakeholders to further their own agendas, and share their place-based knowledge and values. In an effort to understand how stakeholders' contexts, values and knowledge can form and be shared, this project frequently engages with the qualities of 'place', and how one develops relationships with it. While 'space' and 'place' are often used interchangeably in everyday discourse, Yi-Fu Tuan argue that

they have quite different meanings: while space might describe the physical properties of a location, place is a metaphysical concept created by human meaning attributed to that space (Tuan, 1978). He argues that *place* goes beyond mere location—it also carries a social position. He posits: *'What begins as undifferentiated space becomes place as we get to know it better and endow it with value'*. Thus, place is a social, spatio-temporal value, where space and time go together in shaping a person's interpretations. People who inhabit the same physical space may, due to differing past experiences, associate the space with different meanings and values. Spaces mean different things to different people—put simply, it's what makes a house a home. Relph posits that in order to be able to encourage the making of new places or the maintenance and restoration of new ones, we must first further understand how we experience both space and place and be able to describe what makes a place special (Relph, 1976). Dourish and Bell argue that our experiences with space are formed through encounters with social, institutional and historical layers of 'infrastructure' (Dourish and Bell, 2007). They argue that these are the fundamental elements through which we encounter *space* and form *place*, and that highlighting these infrastructures serves as a method to understand the social and cultural practices that occur within a space. Through layers of infrastructure we experience the world and produce, understand and enact cultural meaning, and form relationships with space—a process frequently called 'place-making'. While several previous HCI research projects have engaged with how digital technologies can act as mediators for place and promote place-making, this project will more specifically explore how user-generated content within mobile learning technologies can highlight and utilise these layers of infrastructure for knowledge and value sharing, as well as the empowerment of place stakeholders.

In an effort to investigate how such tools and resources could be used within formal education, this thesis simultaneously explores how such technologies could provide value to schools, and—to assist in the utilisation of learning resources within the local community—how they could be used by teachers to support learning across multiple pedagogies and contexts. The benefits of learning outside of the traditional classroom context is widely documented, particularly in physical contexts relevant to the subject matter (Fiennes et al., 2015; Ofsted, 2008). Lave and Wenger go as far to argue that most people's learning does not actually occur in these traditional classroom settings, arguing that learning is normally situated: embedded within activities, contexts and cultures (Lave et al., 1991). This goes beyond physical contexts and the qualities of space: they argue that a large amount of effective learning occurs through social interactions and exposure to communities of practice. While schools exist within wider communities boasting rich cultural contexts and both cultural and domain knowledge, it is rare that these potential resources are utilised within school curricula (Leat, 2015).

This re-framing of citizens away from consumers and towards a more participatory model in which they are able to take an active role within their relationships with local authorities is a core tenet of the Digital Civics agenda (Olivier and Wright, 2015): a movement within which this project is situated. Several existing Digital Civics projects have explored how digital technologies could help schools utilise domain expertise within local communities (Dodds et al., 2017) and institutions (Venn-Wycherley and Kharrufa, 2019), as well as promoting cultural exchange through school communities (Sarangapani et al., 2016). Mobile learning technologies have been shown to be effective at engaging with physical learning contexts such as museums (Lonsdale et al., 2004), and even enabling the seamless transition of learning between multiple physical contexts (Wong and Looi, 2011). Historically, however, mobile learning technologies have struggled to engage with social learning contexts (Frohberg et al., 2009), meaning that the infrastructures of place have gone under-explored as resources for mobile learning. Therefore, this thesis also explores how mobile learning technologies can be used as tools with which schools can utilise places and communities as learning resources, through various pedagogical approaches.

1.2. Research Question and Objectives

This research is exploratory in nature, following a design-based research approach (detailed in Section 1.3). As a result, the specific aims of each engagement were often dependent upon the findings of the previous studies up until that point. That said, there exists a larger, over-arching research question to guide the project as a whole, formed in response to the findings resulting from the engagements detailed in Section 4.2.1. This main research question is:

> ***In what ways can mobile learning technologies better surface and utilise the civic value of places and empower the communities which give them meaning?***

As the scope of this question makes it somewhat unmanageable when approached as a whole, I have split it into three core research objectives:

1. ***Investigate how existing place and community infrastructures can be better utilised as resources for mobile learning.***

   This thesis aims to fulfill this objective by:

   - Identifying social and physical place infrastructures which can be (or are) utilised as learning resources.

- Investigating what factors may be limiting the use of these learning resources within educational contexts.
- Exploring ways in which mobile learning technologies could mitigate these limiting factors.
- Designing, deploying and evaluating mobile learning technologies which utilise these place infrastructures as learning resources within formal and informal educational contexts.

2. ***Explore how mobile learning technologies can be designed to promote civic learning.***

   This thesis aims to fulfill this objective by:

   - Exploring how place infrastructure can be utilised as civic learning resources.
   - Defining a design space for civic mobile learning technologies using these infrastructures.
   - Investigating how this design space can be addressed through iterative technology deployments.

3. ***Explore how mobile learning technologies can be designed for the empowerment of place stakeholders.***

   This thesis aims to fulfill this objective by:

   - Examining how prior HCI research has designed technologies for stakeholder empowerment.
   - Identifying ways in which mobile learning technologies could act as a vector for stakeholder empowerment.
   - Deploy mobile learning technologies within community groups, and examine their usage by stakeholders in fulfilling their own needs and agendas.

The studies detailed in this thesis aim to meet these objectives. The results of these engagements are summarised in relation to the above research objectives in Section 9.2.

1.3. Research Approach, Methods and Ethics

This work is of an exploratory nature, following a largely qualitative approach. This has been chosen due to the importance of context in the project: examining, understanding and

designing for stakeholders' lived experiences. Qualitative methodologies aim to describe and understand lived experience, rather than to predict and control an objective and generalizable reality—which, when dealing with personal experiences, may not actually exist (MacDonald, 2012). Many of the topics broached over the course of the project are extremely context-dependent: for example, in comparison to more immutable school subjects, such as maths and physics, students across different contexts are likely to have different learning experiences about community heritage and citizenship. The same is likely true for community stakeholders working in different areas of interest and socioeconomic contexts. As such, I needed to appropriate a research approach which supported methods such as design workshops and semi/unstructured interviews for gaining a greater understanding of the design contexts and stakeholder requirements, as well as practical interventions and technology deployments in authentic contexts to develop theory and design recommendations. As Brown argues, if one believes that context matters, disregarding it to assess learning in laboratory settings will only result in an incomplete understanding of these processes in more naturalistic contexts (Brown, 1992). As such, I wanted the research undertaken during this project—both with schools, and with groups of community stakeholders—to be strongly positioned within the participants' current lived contexts. To this end, I chose to follow a 'design-based research' (DBR) approach. This section gives details about DBR, and how it was applied to this research project.

1.3.1. An Introduction to Design-Based Research

Until recent years, situating educational research within real-world (i.e. school classroom) contexts was somewhat uncommon. In the 1990s, there was an increasing frustration with lab-based educational research, and how disconnected it had become from teaching practice. There was an acknowledgement that conflicting stakeholder perspectives could not be modelled objectively through reductionist, lab-based processes. Reeves argues that for academic educational research to be of practical use, '*practitioners must be more directly engaged in the conduct of [it]*' (Reeves, 2000). In the years following this, numerous research approaches have gained in popularity which aim to develop and assess designs in context, often alongside practitioners and other stakeholders.

One of these research approaches which could potentially be used for this project is 'action research' (AR): an approach which seeks to engage with the complex dynamics involved in a given social context, rather than look more more generalizable explanations. The purpose of AR is to impart social change, through the development and assessment of specific actions and professional/community practices (MacDonald, 2012). Furthermore, researchers are

encouraged to recognise that engaging in these practices often necessitates also engaging with complex socio-economic contexts (Stringer, 2013). As such, action research is grounded in authentic contexts, where the researcher also often acts as the domain expert (e.g. teacher, community stakeholder) during interventions. As Hayes notes, in order to allow for the consideration of these contexts, AR methodology is often open-ended and iterative—the primary focus is to implement action (e.g. policy or process changes, the introduction of technology), and the work is judged by the quality of the research results and the feasibility of any solutions that emerge (Hayes, 2011). However, critics of action research argue that this focus upon implementing change is a weakness of action research: Reeves argues that '*[action research features] little to no effort to construct theory, models, or principles to guide future design initiatives*', instead being limited to solving specific problems in specific places (Reeves, 2000). Action research goals are usually focused on a particular program, product, or method, in order to describe, assess and incrementally improve it in context. As such, Reeves notes that such approaches can be seen as a form of evaluation for interventions designed for specific contexts, rather than a research process which produces more broadly applicable design theory. As I wanted to produce contributions which could be still be easily applicable outside of specific contexts and the application of particular technologies, I decided against an action research approach.

In comparison, 'design-based research' (DBR, also known as 'design research', 'design experiments') places a much greater focus on the practical generation and application of theory rather than context-specific artefacts, while still remaining framed in the real world (Zimmerman et al., 2007). The research approach can be summarised by three main characteristics: through collaboration with practitioners, it addresses complex problems within real-world contexts (i.e. classrooms); it produces plausible solutions to these complex problems by integrating existing and hypothesised design principles with the use of technologies; and produces and tests these hypothetical design principles through conducting, reflecting upon and refining innovative learning environments (Brown, 1992; Collins, 1992; Reeves, 2000). In short, the goal of this approach is to solve real-life problems, while simultaneously reflecting upon the results to construct design principles for potential use in other contexts. As such, DBR supports a model of research approach which intends to produce new learning theories, artefacts (e.g. technologies) and practices within naturalistic settings—focusing on understanding the messiness of real-world practice by treating context as a core research focus (Barab and Squire, 2004). Cobb et al. argue that DBR involves 'engineering' forms of learning through interventionist methods which involve some sort of design, and then studying those forms of learning within naturalistic contexts, iteratively revising the context and design in response to results (Cobb et al., 2003). Barab and Squire argue that this active participation of the researcher will require them to '*bring agendas to their work*' as an accountable agent

of necessary change (Barab and Squire, 2004). Furthermore, they argue that during DBR practices, participants are treated closer to co-researchers than subjects—helping produce and develop new practices, rather than the practices simply being done to them. Solidifying this and demonstrating that DBR can be an effective approach within the scope of mobile learning research, Herrington et al. describe how they used DBR to develop design principles for the use of mobile learning technologies within schools: they note that the early stages involved in-depth consultations with practitioners, before then moving onto the iterative development of interventions and theory (Herrington et al., 2009).

However, DBR projects need to account for and adapt to the messiness and complexity of the given research context(s), while still producing findings which will be valuable to others outside of that context. There needs to be a balance between designing for the immediacies of the specific and the overly abstracted, with the findings extending beyond the particulars of a given context. As Barab and Squire argue, design-based research '*strives to generate and advance a particular set of theoretical constructs that transcends the environmental particulars of the contexts in which they were generated, selected, or refined.*' They also argue that the theories resulting from DBR should be justified and evidenced through impact generated by the research within the local context, noting: '*Design-based research that advances theory but does not demonstrate the value of the design in creating an impact on learning in the local context of study has not adequately justified the value of the theory.*' Another potential issue is that the added focus upon the impact of local contexts means that these contexts, and the findings of the studies which take place within them, can rarely be reproduced with any accuracy. As a result, replicability is far more difficult in design-based research than in lab-based research methods. In order to mitigate this, projects need to 'problematize' the process as transparently as possible, providing rich and detailed descriptions of the artefacts, interventions, participants and contexts to support peers in understanding *why* results occurred. In this way, DBR should iteratively develop and test theory in authentic contexts—validating not just the tested design, but the theoretical constructs upon which the design's goals were based. Barab and Squire argue that these theories should be adaptable so that they can be applied in other contexts, reducing the need to "sterilize" context for the sake of replicability.

1.3.2. Applying DBR & Data Analysis Methods

Due to the nature of the research subject matter being so intrinsically linked to local context, this project attempts to follow a design-based research methodology. As such, these working contexts are included as a core feature of the studies' engagements and findings, as they

are likely to affect how participants approach and use mobile technologies and any frameworks produced to support them. In order to 'problematize' these contexts through rich and detailed descriptions, this project favours in-depth and long-term engagements with local stakeholders and schools where possible. These engagements are impact focused, rather than driven by the collection of quantitative data: assessing the performance of theory-driven designs for iteration and further validation in multiple contexts. In line with the interventionist DBR approach, as the researcher I take an active role during these engagements, bringing my own research agenda which will shape the activities in each study. This agenda and my form of participation during research studies varied as the project progressed, and is detailed in section 1.3.3.

As noted by Herrington et al., design-based research projects take place over several stages: problem analysis and stakeholder *consultation*; the *design* of an initial intervention; the implementation of this *intervention* over multiple iterations, with *adjustments* and improvements made between deployments; and the creation of design principles based upon the theory, practice and *reflection* of the previous phases (Herrington et al., 2009).

Due to the variety of different engagement contexts and engagement lengths, a variety of exploratory, qualitative research methods were used during the *consultation* stage. The methods used in this stage include semi and unstructured interviews, focus groups, participant workshops, and deployments with technology probes. The method of coming into contact with each participant group is noted when appropriate, as each differ according to context. When other more specific and/or one-off methods are used during an engagement (e.g. particular workshop activities), they are discussed in this document as and when appropriate.

The *design* stage consisted of taking the combined findings from the literature review and the consultation stage to produce a series of design goals for an appropriate mobile learning technology. An initial version of this technology was then produced with these goals in mind.

The *intervention* stage consisted of the repeated deployment and assessment of the technology's design, with a variety of stakeholders in numerous contexts. These stakeholders include school students, teachers and volunteers within community groups. Unless otherwise noted, a member of the research team (usually just myself) was present for all engagements and technology deployments. Observations were recorded through field notes whenever possible, however these engagements frequently required me to lead sessions (e.g. running workshops, instructing classroom activities), provide technical support (i.e. in the event of software malfunctions or users requiring support), or simply featured too many participants for me to keep track of. In these cases, additional details and impressions were obtained

from co-organisers, such as teachers and community stakeholders. To gain a more detailed understanding of the intervention's performance and the impact of the deployment context, additional impressions were also gathered from participants after each intervention. This was preferably done through semi-structured interviews of around 30 minutes in length, held either immediately following each study or, if that isn't practical, in the days following. These interviews were audio recorded, and each typically aimed to gain an understanding of the participant's opinions on how that particular engagement went, what could be improved about the technology or process, and the reasoning behind any decisions that the participant might have made.

Between these interventions, the technology's design was *adjusted* according to each deployment's findings and stakeholder feedback. To accurately construct these findings, a strong understanding of the data is needed. To ensure that I have an intimate familiarization with the data, audio recordings were listened to before being transcribed. They were either fully transcribed—by myself or through external professional and trusted transcription services—or only partially by myself, if they contained lots of 'dead air' or non-pertinent conversations (e.g. wind noise during school trips, participant chatter about personal issues). These transcriptions were collated along with other sources of data (e.g. notes, photos) per engagement. Initial codes were then be created, through an inductive thematic analysis (Nowell et al., 2017), which consisted of exploratory, line-by-line coding—the attaching of pertinent and specific labels to data snippets. This coding process was done through the re-reading of printed out transcripts, highlighting data with different coloured highlighter pens and labels according to the given code. The production of these codes allows me to focus on specific and recurring characteristics within the data, allowing me to move from addressing unstructured data to developing a greater understanding of what is going on (Richards and Morse, 2013). These coded snippets are then typed into a Microsoft Word document for ease of reference and categorisation: after transfer, codes are then categorised into themes pertinent for discussion. An example of the resulting Word document has been included in section A.5. Where possible, these codes and themes are triangulated with other researchers (creating codes independently, and then comparing results), however this was not always possible due to the amount of work it puts upon colleagues—when this was the case, less thorough peer debriefings where the case for each theme was reviewed were performed with the paper co-authors mentioned at the beginning of each chapter, as well as my supervisor Dr. Ahmed Kharrufa. The data presented in chapter 2 was triangulated with Dr. Clara Crivellaro, and the results of the notes and transcripts generated in section 7.1 were triangulated with Dr. Pradthana Jarusriboonchai. An example of the results of this triangulation discussion has been included in section A.4. After themes have been generated

from studies, implications for design are then produced as a result of *reflection* upon the data and generated themes.

1.3.3. The Role of the Researcher & the Developed Technology

As a researcher following DBR practices, I approached this research project with the intention of promoting change: taking an active involvement in the research studies: as a technology designer and expert, and as a teaching assistant within the school environment (acting as a 'co-investigator' with teachers). My overall agenda corresponded to my research objectives: to investigate, create and promote the use of mobile technologies which can utilise existing community knowledge, agendas and infrastructures within formal school systems.

Under this overarching agenda, this project's DBR cycle resulted in the creation of 'OurPlace': a mobile learning smartphone application which is used within studies throughout the project. However, the specifics of this research agenda—as well as the role of OurPlace and the degree to which it was the focus of the research—varied over the course of the project. Over the course of the studies, OurPlace and its prototypes take on three different roles as the agenda shifted: a technology and design *probe*, the research *object*, and an *archetype* for exploring the potential roles of mobile technologies in new approaches to mobile learning.

The Technology as a Probe

My early research agenda during this project focused on investigating how mobile technologies could effectively assist stakeholders with sharing their knowledge for use with the rest of the community, especially schools. However, despite being a relative expert regarding mobile technology development, I did not have a strong understanding of the domains of teaching and community knowledge sharing. As such, the studies detailed in Chapter 4 and the studies with the Heritage Forum in Chapter 6 are primarily concerned with identifying stakeholder's existing practices and requirements, and responding to those requirements through the design, development and deployment of a prototype technology. Within these studies, the OurPlace application's early paper and digital prototypes served as probes: giving participants a focal point around which discussions could be structured, to gain a better understanding of different stakeholders' issues and practices within their own contexts and their own ways of promoting civic learning. As such, the technology was used as a method for data collection, rather than necessarily a solution for the participants' contexts. As well as stakeholder interviews and site visits, this was done through a variety of methods which utilised

the technology: early workshops utilised paper prototypes, where discussions of potential features and applications of the technology gave insight into stakeholders' values, practices and requirements; prototype deployments were held, where early versions of the application were used by school groups to understand the role and influence of the technology in outdoor learning settings; and later workshops (e.g. section 6.2.4) featured more advanced versions of the application to act as a probe for participant reflection, aiding discussion around visitor engagement and the potential roles of (and issues with utilising) mobile technologies. During all of these engagements, I took an active role in explaining the technology's capabilities (unless the activity was deliberately ambiguous); supported its use by teachers, children and community stakeholders through tech-support and troubleshooting; provided Android tablet devices where required; and acted as a teaching assistant to manage students during school engagements.

The Technology as the Object

After the use of the technology and its design process as a probe for discussion, a number of design suggestions and requirements has been identified. At this point, my research agenda shifted towards producing as effective technology solution as possible in response to these findings. In an effort to evaluate and improve OurPlace in relation to these requirements, Chapters 6 and 7 largely place focus on it as the research object: using OurPlace in interventions, and framing it as a potential solution to the issues previously identified. Research methods employed during this stage consisted of observed technology deployments with community groups and schools (both in and outside of the classroom) and semi-structured interviews, usually both before and after deployments. As before, I supported the use of mobile technology in schools and communities through taking the roles of a technology expert and teaching assistant and providing access to devices where necessary. However, I did not take a leading role as educator, instead deferring to teachers as the experts of the domains of education and student management. The inclusion of OurPlace as OurPlace as a technology intervention was designed before each engagement, with the teachers taking co-researcher roles.

The Technology as an Archetype

As OurPlace became more refined and was shown to address many of the identified design requirements, in Chapter 8 the research focus shifted away from the design, development and iteration of the OurPlace platform, to investigating how such technologies can be more

effectively used within the UK's school system. As such, my research agenda focused on the production of a realistic framework for the use of mobile learning technologies within schools, created through a DBR workflow. Within this context, OurPlace was framed as an archetype for mobile learning technologies: one which could be substituted by other technologies with minor alterations to the framework's implementation. OurPlace was chosen as the archetype technology for two reasons: firstly, the previous studies had demonstrated that as a tool, OurPlace was suitable for use across multiple learning contexts; and secondly, I was deeply familiar with the platform, could adapt its functionality if required, and could advise on its use. Research methods employed during this stage consisted of observed technology deployments with community groups and schools (both in and outside of the classroom) and semi-structured interviews, usually both before and after deployments. While I wasn't able to also investigate the implementation of the framework with other technologies due to time constraints, I did provide suggestions of how other technologies could be employed. As this teaching framework was the design intervention (rather than the technology itself), these engagements saw me take on more of a leading role in teaching contexts to ensure that it was delivered in as consistent a manner as possible between contexts. However, as each teaching context had its own requirements, teachers' insights were still integral to each study, and they were still treated as co-researchers.

1.3.4. Ethics and Consent

All interactions and data collection have been approved by and conform to the requirements of Newcastle University's ethics committee. Consent forms are required to be completed by each participant (or, in the case of schools, students' parents) prior to the commencement of each study. Accompanied by an information sheet (see Appendix A.1) detailing the purpose and details of each study as well as contact details of the research team, these consent forms (see Appendix A.2) ask for affirmative consent for a number of factors, including: general participation in the study, an understanding that they can withdraw consent at any time, consent for capturing photographs of the participant, and consent for capturing audio recordings. Participants are told that their consent for each of these could be granted, denied or withdrawn at any time. Any identifiable elements (i.e. names, photographs) have been anonymised prior to publishing. In accordance with Newcastle University's ethics policies, participant data is securely stored on Microsoft OneDrive.

1.4. Summary of Contributions

The course of conducting the investigations discussed in this thesis has resulted in a number of contributions being made to the field of Human Computer Interaction. In order of their value, these contributions are:

1. An introduction and exploration of the concept of 'project-based mobile learning' (PBML) through the creation, application, and iteration of a PBML framework in four different schools and a summer school of Travelling Showmen. Suggestions for the framework's reconfiguration in response to contextual challenges are also contributed, along with reflections on the PBML process, including how PBML harnessed students' existing desires for independence, and how it could offer new avenues for leveraging place as a learning resource.

2. Implications for design regarding how mobile learning technologies can be configured to support place-making, and recommendations as to how researchers and designers can better utilise the infrastructures of place as resources for civic mobile learning.

3. The introduction of a model for a social design space for mobile learning technologies, where relationship infrastructures connect stakeholders and learners in space and place. The model illustrates how 'traditional' mobile learning approaches frequently don't meaningfully engage with these infrastructures, and are either independent of the learner's context or concentrate solely on the physical aspects of the environment. Implications for designing technologies which aim to support place-making within this space are also provided.

4. The design and development of OurPlace: an open-source mobile learning platform designed to support teachers, students and community stakeholders in creating, sharing and engaging with bespoke mobile learning activities seamlessly, across multiple learning contexts. This document shows OurPlace to be an adaptable research tool, and it has been used in three (as of the time of writing) other projects held by different researchers, each of which engage either with schoolchildren or adult community stakeholders.

5. Insights from several years' worth of a variety of engagements with multiple place stakeholders, including: embedded, multi-year relationships with volunteer-led organisations; longitudinal and short studies with teachers and students from seven different schools; and one-off technology deployments and public workshops, ranging from three to fifty participants in size.

6. Reports on the use of OurPlace in both formal and informal learning contexts, with discussions around how it and similar technologies can promote civic engagement and inquiry; support empowerment through encouraging creativity and content ownership; and assist in seamless learning teaching practices by being an adaptable, supporting toolkit.

7. This project has also had a notable impact within the North East region of England:

    - Approximately 400 schoolchildren have engaged with the technology, providing opportunities for learning outside of the classroom—frequently in authentic place and/or engaging with community stakeholders.
    - Multiple stakeholder groups have used the technology to create mobile learning activities, trails and installations.
    - A Community Rail Partnership has successfully applied for grants to fund the creation of a job dedicated to using OurPlace, running engagements with children and local communities centred along a railway line in the North of England (detailed in section A.3.3).

By their nature, many of the insights and contributions from these works are heavily contextual. However, as discussed earlier, the employed design-based research and reporting approach means that the majority of the findings and discussions should be adaptable for use in other contexts. Furthermore, the PBML framework and the presented implications for design have been deliberately configured to support their application in different contexts and with different technologies.

1.5. Document Structure

The remainder of this thesis consists of eight chapters, each concerning a different subject or series of studies:

Chapter 2 gives a brief introduction to prior literature produced by humanist geographers and HCI researchers relating to our relationships with place, and how technology can influence these relationships. Subjects covered include: different interpretations of place, and how it differs from space; ways in which individuals' relationships with place can be experienced and described; the concept of place-making, and how relationships with place can be developed; how technology can and has been used to promote the development of

these relationships in HCI research; and an overview of Digital Civics projects which have engaged with place-making.

Chapter 3 gives a brief overview of some of the previous research that has been conducted concerning mobile learning, constructionism, and project-based learning. Subjects covered include: situated learning and communities of practice; civic learning; an overview of some existing mobile learning research; ways in which the mobile learning technologies have engaged with the infrastructures which make up place; mobile technologies supporting learning seamlessly across multiple contexts; and the use of mobile learning technologies to support constructionist and project-based learning pedagogies.

Chapter 4 covers the first series of engagements, which aimed to gain an understanding of the potential for mobile technologies to explore the different stakeholders' current issues and practices; explore how these can be used as resources for civic learning; and develop generalizable design requirements for future technologies for m-learning within civic space. While the chapter itself is a self-contained DBR cycle, it exists as the initial *consultation* and the beginning of the *design* phases of the wider project. The findings of these engagements culminate in a model of the design space for civic mobile learning technologies, along for implications for designing technologies within this space.

Chapter 5 presents a number of design goals for a place-based, mobile learning technology for use within formal and informal learning contexts. These goals were formulated in response to the studies and literature covered up until this point. The chapter then gives a detailed overview of OurPlace—the mobile learning platform created in response to these design goals.

Chapter 6 describes an multiyear ethnographic study with a local heritage forum, and the engagements which came as a result of it. The findings of these engagements are discussed, particularly around the role of technology in satisfying stakeholders' desires, requirements and the potential tensions that can exist between technology, stakeholders, and the places they care about. These findings were also used to assess if OurPlace met the original design goals relating to local stakeholders that were set out in Chapter 5.

Chapter 7 covers studies in formal education settings, most of which ran concurrently to those covered in Chapter 6. In these studies, teachers and researchers created OurPlace content to be completed by school students across multiple engagements, investigating the use of OurPlace as a seamless, place-based learning tool. The findings of these studies are presented and discussed through themes relating to seamless learning practices, engaging and empowering learners through control and content ownership, and the use of mobile

learning technologies for civic engagement and inquiry. These findings were also used to assess if OurPlace met the design goals relating to learning in formal education contexts.

Chapter 8 explores the use of mobile learning platforms such as OurPlace in supporting project-based learning pedagogies, where students take the role of Activity designer and the application is used as a component within a larger project. The concept of 'project-based mobile learning' (PBML) is introduced through the creation and application of a PBML framework. This chapter covers the framework, suggestions for its configuration in response to contextual challenges, reflections on how PBML can harness students' existing desires for independence, and how it could offer new avenues for leveraging place as a learning resource.

Chapter 9 discusses the findings identified during the previously discussed studies, with discussions pertaining to how mobile learning technologies can be configured to support place-making, and recommendations as to how researchers and designers can better utilise the infrastructures of place as resources for civic mobile learning. I also discuss some of the study's limitations and respond to the research questions presented in Section 1.2.

Chapter 2. Space, Place and Infrastructure

This chapter presents how previous research has explored and examined the qualities of space and place, people's relationships to them and how these factors have influenced educational theory and practice. I also examine how the Human Computer Interaction (HCI) research community has approached this as a design space, particularly through the lens of the Digital Civics agenda (Olivier and Wright, 2015).

2.1. Space and Place

As noted earlier, Tuan argues that space and place are two concepts which respectively describe the physical and metaphysical properties of a location (Tuan, 1978). While many of their contemporaries treated geography as a literal science of the physical properties of the Earth, humanist geographers such as Tuan and Relph (Relph, 1976) positioned themselves within a more social framing, proposing the treatment of geography as more of a social science. Tuan argues that place is formed by our experiences with it: the more intimate a relationship an individual has with a space, the less abstract their cognition of it becomes. Harrison and Dourish similarly posit that while 'space' is the three-dimensional structure of the world, 'place' is an "understood reality" of mutually held and available cultural understandings of behaviour and action (Harrison and Dourish, 1996). They argue that while we are *located* in space, we *act* in place: the relationships we have with particular locations frame our behaviours within them. Furthermore, they argue that place can exist without an accompanying physical space: for example, through building behavioural expectations in virtual or augmented realities. They also posit that expected behaviours within places also change with time: be that time of day, or as larger trends change over months and years. Malpas argues that place, while related to space and time, is distinct from them, and is "methodologically and ontologically fundamental" (Malpas, 1999). He proposes that place is tied to both subjectivity and objectivity, and that places become significant from the grounding of our experiences in them, rather than the experiences themselves. As such, he argues that *who* we are reflects *where* we are: while the land carries 'a cultural memory and store-

house of ideas', our identities are also formed by the places we inhabit. This also raises the possibility of individuals seeing places as a part of their identity: a potential explanation for place stakeholders volunteering their time and resources towards a particular site's upkeep.

Relph takes a more phenomenological perspective, and argues that in order to be able to encourage the making of new places or the maintenance and restoration of new ones, we must first further understand how we experience both space and place and be able to describe what makes a place special (Relph, 1976). He argues that we experience place on a spectrum (varying from pragmatic and perceptual on one end and abstract thought on the other) in instances of various intensity throughout everyday life, often subconsciously, with each playing a part in how we experience space. On the more abstract side of this continuum, Relph introduces the concept of *insideness*, which describes the relationship someone has with a place. He posits that if someone feels *inside* a place they feel positively about it (e.g. safe, enclosed, at ease). *Outsideness* describes the opposite (e.g. threatened, exposed, stressed), which would often occur when someone feels a division between themselves and their lived environment (feeling homesick, for example). Relph argues that the more 'inside' of a place a person feels, the stronger their identity with it will be. Furthermore, he also claims that there are qualities and characteristics of place that can affect how we experience them: that environments which provide 'genuine experiences' through direct, unmediated access to their social qualities and constructs (e.g. their local heritage) offer an *'authentic'* sense of place. However, he argues that this is increasingly being overshadowed in our modern era by an attitude he refers to as *'placelessness'*: *'the casual eradication of distinctive places and the making of standardised landscapes that results from an insensitivity to the significance of place'*. Relph asserts that by undervaluing places' distinctive characteristics, being overly concerned with efficiency and accepting environments which are interchangeable to the point of anonymity, we run the risk of normalising *'inauthentic'* experiences of place. The result is something superficial and contrived, and unlikely to represent communities authentically. However, this framing of 'cookie-cutter' town planning as being 'placeless' has received criticism for being condescending and elitist towards towns often lacking in social mobility, such as cities in Northern England (Cresswell, 2016). Relph also warns of the dangers of 'museumisation'—the simplification and sanitisation of history to create a more palatable ideal. He argues that by highlighting only the best bits of local history, we run the risk of creating a 'Disneyfied', inauthentic image of place. Smith criticises Relph for lacking a degree of perspective in this regard (e.g. not considering '*the wonder of a child's eyes at Disneyland*'), and for not offering suggestions for how to go about actually developing 'authentic place': rather, Relph simply argues that attempts to create place will only reinforce mass stereotypes of it (Smith, 1978).

While I am partial to Relph's more phenomenological perspective, the criticisms regarding a potential lack of accounting for perspective ring true: if place is such a subjective, experiential concept, how could one be able to label another's neighbourhood as 'placeless'? Ironically, this fits Relph's own words: 'insensitivity to the significance of place'. Instead of being these spaces being placeless, it implies to me that the value of places and their *authenticity* is merely less accessible to observers, potentially due to cultural and socio-economic differences between them the place's stakeholders. I believe that the implications of these arguments on HCI research is that when designing for or conducting research within a location, we must gain perspective on it: become more aware of the social constructs which underpin it, give it value to its stakeholders and create *place*. To better understand these factors, it's likely that we as researchers will have to grow relationships with a place over time through direct habitation, or at least involve existing stakeholders as participants who have ongoing relationships with it. However, this becomes both more interesting and potentially problematic when accounting for Tuan's arguments of the influence of personal experience–because a person's place attachment is formed based upon individual experience, researchers should be aware that their perceptions of place may not align with others', running the risk of inappropriate design decisions if not handled with care.

2.2. Infrastructures of Place

In order to design technologies which support the highlighting and sharing of place with other people, we first need an understanding of how place is encountered, experienced and understood. In her ethnographical study of physical infrastructure (such as the sewers and power supplies of cities, and the stairs and ramps of building entrances), Star argues that meaningful ethnographic study of these systems can open up an *'ecological understanding'* of place (Star, 1999). She posits that infrastructure is *'both relational and ecological—it means different things to different groups and is part of the balance of action, tools and the built environment, inseparable from them'*. In this regard, the humanist geographer's place and Star's infrastructure are similar in many ways. Star argues that the study of the physical infrastructure of sewerage, water and power supplies within cities can help one gain insights into distributional justice and planning power. One given example is that a keen observation of the usage (or omission) of stairs, ramps and railings can give an impression of institutional attitudes towards—and considerations of—people living with physical disabilities. I find that this argument holds merit, and it isn't hard to find real-world instances of it: for example, the staircase outside Vancouver Law Courts (Figure 2.1) has been described by an accessibility blogger as *'a serious disaster waiting to happen [and]*

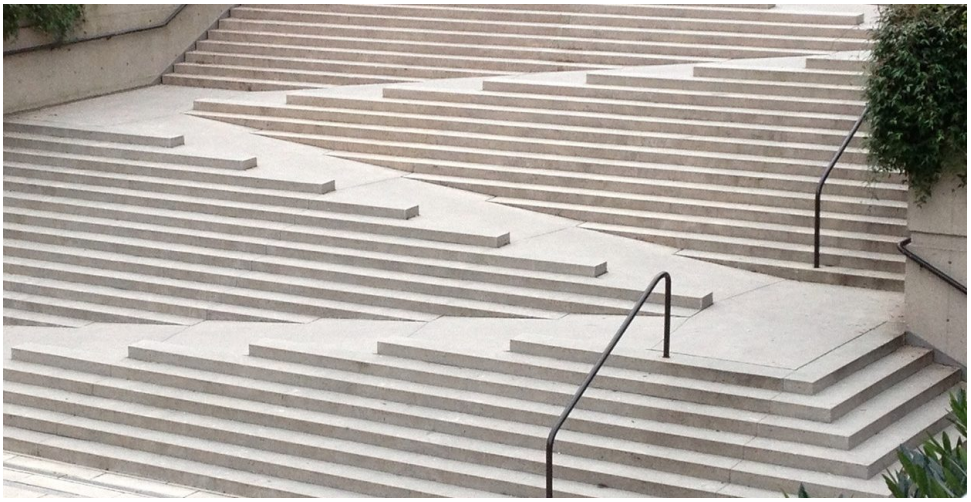

Figure 2.1 The staircase outside of Vancouver Law Court, criticised for its lack of accessibility.

dangerous for everyone not just those with disabilities' (Wheeler-Hall, 2017). Another modern example of infrastructure reflecting an unequal distribution of power would be the water crisis in Flint, Michigan (Clark, 2018)—the cause and response to which has been labelled as systemic environmental racism (Michigan Civil Rights Commission, 2017). Star recalls that few participants in one of her projects utilised the final system that her team designed, despite the researchers following the principles of participatory design throughout the process. They identified that this was not because of usability issues with the interface, but rather how their design was a poor fit with the infrastructures the participants had to work with. The article highlights that the study of infrastructure in an ethnographic enquiry can uncover tacit conventions of everyday practices, allowing the unpacking of relationships between different communities, interest groups and perspectives.

Dourish and Bell argue that infrastructure doesn't just simply comprise of a space's physical properties, but also of different social, institutional and historical factors (Dourish, 2006; Dourish and Bell, 2007). They claim that these infrastructures are both embedded into social structures, whilst also serving as structuring mechanisms themselves. Infrastructures such as street names, regions, traffic flows and calls to prayer shape a person's experience by making it meaningful in different ways, but are themselves moulded over time into configurations which support social practice. Dourish and Bell argue that highlighting these infrastructures serves as a method to understand the social and cultural practices that occur within a space: the organisation of space becomes layers of infrastructure, through which we experience the world and produce, understand and enact cultural meaning. While the authors do not refer to the concept of 'place', I posit that the combination of the arguments by Star and Dourish and Bell build upon and solidify Relph's notion that we have various forms of encounters with place in our everyday lives: that these infrastructures are the fundamental elements through

which we encounter *space* and form *place*. In line with Relph's argument that our encounters with place take can be placed on a spectrum from the perceptible to the abstract, I argue that these encounters can be seen to be with various forms of place infrastructure (be that literal or social), created by our actions within space and place—such as the building of physical infrastructure or the enactment of daily rituals.

Dourish and Bell conclude with some implications for design: they argue that because space is organized both culturally as well as physically, a cultural understanding of a place can provide meaningful and coherent framing to relate it to human activities. In the context of HCI, the technologies we design can act as infrastructure within a place, with each having varied social and cultural interpretations and meanings. They also argue that technology designers need to be aware that both space and place feature both physical and social boundaries and transitions, and that these are not always things that technology should try to bridge. They claim these boundaries are frequently used by inhabitants as an asset, and that technologies which introduce 'seamlessness' can detract from a place's value. Finally, Dourish and Bell argue that because a) new technology can introduce new layers of infrastructure and b) our encounters with places are formed through their layers of infrastructure, introducing new technologies to a location can inherently cause people to 're-encounter' and re-evaluate it as a space and place. In summary: technology can—as a layer of social infrastructure—act as a destabilizing, transformative force in how we experience place, and can affect stakeholders' experiences with place in different ways.

2.3. Place-making

Encounters with these social, cultural and economic infrastructures are especially important for forming relationships with space—a process frequently called 'place-making'. This section will cover some of the ways that researchers have approached place-making, including how it occurs; how existing relationships with place can be surfaced or articulated; and how technologies can be configured to support place-making processes.

2.3.1. Building Relationships with Place

While Tuan takes a passive outlook on the creation of place (where our relationships build through experience over time), Harrison and Dourish give a more active and designerly perspective: they argue that '*Space is the opportunity; place is the understood reality*' (Harrison and Dourish, 1996). In other words, they posit that our relationships with place are things that

can be encouraged through design. It also implies a form of learning: place forms through the development of an *understanding* of reality. These understandings of place could even be up for differing interpretations—after all, an understanding is based on an individual's perspective. For the purposes of this project, I want to explore how mobile learning technologies might utilise these opportunities afforded by space as learning resources, and how place-making can be utilised as a mobile learning experience.

Relph describes a number of ways in which a person's relationship with a new place could form. Building on his concepts of *in/outsideness*, he introduces the concept of *vicarious* insideness—that which occurs when someone engages with a place through their imagination (e.g. through experiencing a place in works of art or reading about it in a book) (Relph, 2018). He claims it is most pronounced when a place's depiction corresponds with our own experiences of places we are familiar with. Relph notes another, more deliberate form of place-making called *empathetic* insideness, which is a very deliberate attempt by an individual to understand a place in depth. This requires a *'willingness to be open to the significances of place, [with] the hope to see it as rich in meaning for those whose place it is'*. These factors can coalesce into authentic and self-conscious place-making, where *'there is sensitivity to the significance of place in everyday life'*, and can be encountered in instances where communities and individuals have invested hopes and ideals in actively making a place for themselves. Educational technologies may be able to use these types of place-making, providing opportunities for people to develop relationships with place through learning experiences. Mobile learning technologies could be particularly effective at this, as they could offer experiences which support the development of empathetic insideness within the authentic learning context, without a reliance on doing this remotely (requiring the learner to be open to vicarious insideness).

In their review of environmental psychology-based sense-of-place literature, Kudryavtsev et al. note that many researchers suggest that a 'sense of place' is a combination of two complementary concepts: *place attachment* and *place meaning* (Kudryavtsev et al., 2012). *Place attachment* refers to the bond between people and places—the degree to how much an individual or people value or identify with a particular place. This includes the extent to which a place satisfies an individual's personal requirements, as well as how a place becomes a part of an individual's personal identity and—at least partly—defines them as a person. In this way, place attachment fits with Malpas' outlook on our relationship with place: that our identities are formed by the places we inhabit, and that *who* we are reflects *where* we are (Malpas, 1999). Kudryavtsev et al. argue that *place meaning*, however, refers to something closer to the humanist geographers' interpretations of place: the meanings that individuals ascribe to settings that they are familiar with, reflecting their environment, social

interactions, culture, politics, economics and history. They note that within the context of environmental education, relatively little research has been done on the combined effects of place attachment and place meaning on behavioural change. However, they hypothesize that a combination of both factors would be more effective at fostering place-based behaviours (in this case, pro-environmental actions) than either taken separately. From examinations of previous works, they suggest that place attachment which hasn't placed an emphasis on ecological elements may not necessarily contribute to pro-environmental behaviour—they suggest that also introducing a pro-environmental place meaning could foster this behaviour more effectively. One might also speculate that this could be applied to many other infrastructural elements of place, outside of the topic of environmentalism. For example, someone might not concern themselves with the socio-economic issues surrounding funding the maintenance of a local park, even if they have built a 'place attachment' through a dependence on it for walking their dog. Fostering this element within someone's place identity would likely involve introducing them to relevant infrastructure and forming new place meanings. This project will explore the potential for mobile learning technologies in developing (or demonstrating others') place meaning and place attachment, highlighting both as opportunities for learning.

2.3.2. Technology as a Mediator for Place-Making

Relph argues that one of the primary ways to build a relationship with space is through having experiences with it, and notes that the majority of modern experiences of landscapes are mediated by machines (Relph, 1976). Having written his book in 1976, the dominant machine of the time was the automobile. He posits that while at the time there was a narrative that cars had separated people from landscapes and places, this was reductive—the availability of the automobile also extended people's mobility and fundamentally changed how they experienced the world by allowing for new options, comforts and experiences with places that otherwise would likely be inaccessible. Similar arguments can be levied for and against the dominant machine of the 201X's—the smartphone. A common narrative is that digital technologies separate us from 'the real world' through distraction, and this may be true in many cases. For example, an over-reliance on technology for navigation (e.g. Google Maps) has led many to repeatedly use the same predetermined routes through their local environment, reducing their exploration and limiting opportunities for building relationships with new places (Löchtefeld, 2019). But, similarly to the automobile, the increasing ubiquity of mobile technologies has also dramatically increased users' access to information and experiences that had previously been inaccessible. Modern mobile devices act as a portal to places (both physical and virtual) and their stakeholders all over the world. As such, mobile learning

technologies have an opportunity to highlight these stakeholders and their knowledge and values, both in-situ and remotely—allowing learners access to new interpretations of place.

Harrison and Dourish posit that as place is created by patterns of use, 'placeness' is not something that we can design technologies *in* (Harrison and Dourish, 1996). They argue, however, that we can support placeness by designing *for* it: creating new spaces (or augmenting existing ones) within which people can make place. They argue that technologies can support the emergence of a sense of place through supporting adaptation and appropriation: allowing for individuals to re-arrange elements of (physical or virtual) space to suit and reflect their lives and sense of self. Extending this to the domain of mobile learning, it would make sense that sharing these arrangements and self-reflections would be a way of sharing one's own interpretations and understanding of place (for example, community heritage or personal history) and supporting vicarious insideness with others.

Giaccardi et al. note that this new prevalence of digital technologies has opened the door for new ways of interacting with heritage (Giaccardi et al., 2008). They claim that by using 'cross-media interaction' (the use of multiple forms of both media and technology) to create new socio-technical infrastructures, novel interactions can be enabled between local communities and their places of heritage within authentic environmental settings. These infrastructures allow for new cultural experiences, articulating and exploring existing people's relationships with place in new ways. I would argue that these experiences open up new opportunities for visitors to build place attachment through empathetic, vicarious insideness—supporting the creation of 'placeness' as suggested by Harrison and Dourish. Giaccardi et al. similarly argue that sustaining this knowledge of social relations is a place-making process, which technology can support by supplying communication and interaction spaces in which communities can engage with the physical and social settings of heritage. They argue that little HCI design had been done with the aim of reinforcing (or recovering if lost) the relationships between communities and their places of meaning, offering that one possible 'solution' could be cross-media interactions. These interactions would allow people to *'express their perceptions, interpretations and expectations about the heritage'*, reinforcing a sense of place through repeated interactions over time. They note that of particular importance is making heritage a 'living practice': *'giving people active and supportive roles, [engaging] them in connecting to each others' experiences, considering each other's interpretations, and building insights that may lead to new meanings and relationships'*. Additionally, Giaccardi et al. suggest that the use of technical infrastructure alone is not enough to support heritage practice and place-making—they argue that social infrastructure is necessary for the support and regulation of community participation over time. They also suggest that designs in this space should legitimise personal accounts as far as possible, in order to encourage the

Figure 2.2 Jeff Gerstmann shows his colleagues his childhood school in Google Earth VR.

collection and conservation of resources—many of which are likely to have unexpected value. This is also linked to another important factor that the authors recognise: the participants' sense of ownership over the content, which strengthens their relationship with the heritage and places of meaning.

Highlighting the distinction between space and place, technology can also support 'authentic', personal experiences with place without the need to be at the same geographic location. For example, Google Earth VR allows users to explore most locations in the world from a first-person perspective, using a combination of satellite imagery, street-level photography, and machine learning to generate recognisable 3D environments (Google, 2016). Taken as presented, the software is more reminiscent of *space* rather than *place*—the software does not attempt ascribe any emotional connections or value to particular places, outside of featured landmarks (e.g. the Eiffel Tower).

However, during a live-streamed internet show, video game critic Jeff Gerstmann demonstrated the software, claiming that the sense of place offered by the experience was *'profound, and almost emotional'* (Gerstmann, 2016). Rather than explore far off locations which would be otherwise inaccessible or the featured landmarks which are of worldwide renown, Gerstmann opted to explore places he already had relationships with: *'Last night I just took my whole commute home, stood in my own backyard.'* (Figure 2.2). In this instance Gerstmann used Google Earth VR to highlight his place identity, sharing his relationship with place with thousands of others, allowing them to vicariously encounter it through the Internet. Examples such as this highlight the potential for technologies to allow the sharing of differ-

ent interpretations of space meaning, by giving stakeholders the means to share their past experiences, knowledge and insights to encourage vicarious insideness.

2.3.3. Place-Making in HCI Research

The HCI research community has been investigating this potential for place-making through technology for some time. McCarthy and Wright posit that place-making can be viewed as a dialogical process, in which a person's relationship to a place develops over time through repeated relational interaction and interpretation (McCarthy and Wright, 2005). They argue that this is a two-way 'conversation-like' relationship between the person and their environment, with both contributing qualities which together build a relationship. For example, this might include the person's sensory experiences with the environment, the socio-cultural history attached to it and even the outlook of possible future engagements between the two. The authors suggest that for technologies to help people feel 'in place', they should engage at a personal level, rather than treat them as an anonymous entity.

A good demonstration of many of these concepts in practice can be seen in a study by Crivellaro et al., who worked with multiple heterogeneous stakeholders in the context of a housing estate undergoing urban regeneration (Crivellaro et al., 2016). Through a series of engagements with current and former residents, the research team designed walking trails through the area and used a technology probe to collect participants' reflections. Walking trails were chosen as they were *'seen as a means of encouraging a genuine engagement with the environment and stimulated pause and reflection'*. The engagement was configured to encourage the participants to convey what they valued about the estate and took a slower pace, facilitating *'organic growth'* and the participants developing a sense of ownership of the trail. The participants were keen to ensure that the trail represented their estate both fairly and accurately—while the area had suffered from negative stigmas which they viewed as being unjust, they were also wary of portraying it in an unrealistically positive manner. This mirrors Relph's concerns around the 'Disneyfication' of heritage: glossing over any negative aspects to make the consumption of it more appealing to a modern audience (Relph, 2018). Furthermore, the residents viewed their creation of the trail and audio logs as a form of both 'anticipatory archaeology' (by documenting the regeneration process) and social curation: I posit that this can be looked at as them using the probe to safeguard their sense of place from being expunged during the estate's redevelopment, decoupling their interpretation of place from space through the use of a socio-technical infrastructure. This wasn't just for their own reflection on the past, either: these memories were recorded so that others could listen to them, allowing the stakeholders to take roles in other people's place-making with the estate.

As the authors note: *'the importance of "giving something back" points to the residents' desire to find value in their stories and actions, and see their contributions as having a wider and lasting impact.'* The participants were re-constructing the place's identity by using the stories of those who contributed to it. This can be seen to support McCarthy and Wright's positioning of place-making as a dialogical process (McCarthy and Wright, 2005): the participants are attempting to continue a conversation regarding place. Potentially as a way to make up for 'losing' the estate as they knew it, the participants were creating further dialogue with future residents about their experiences of place. The engagements were designed to highlight the heterogeny of the stakeholders' experiences and opinions, while using the estate as a 'common ground' with which all of the participants were familiar. The authors argue that collecting a diverse set of accounts that *'enact place over time'* can open a space for more genuine portrayals of community. As McCarthy and Wright argued, the relationships between the estate and the stakeholders were seen to be built up on past experiences, the current situation and the outlook for possible future engagements. The participating stakeholders often had their own motivations and agendas (e.g. showing that life on the estate was generally more positive than its reputation would have suggested), surfaced by the probes thanks to their engagement on a personal level, recognising the participants as individuals. Such examples highlight the potential for technologies—particularly mobile ones, which can be taken to relevant physical contexts—for collecting, sharing and highlighting the differences between various stakeholders' place attachments and place meanings.

McCarthy and Wright also note that mobile devices are particularly well suited to engaging people on this personal level: by their nature, phones are intrinsically personal devices, and as the authors argue *'allow people to capture the intimacy of interpersonal relations while moving from one place to another in a public sphere, blurring the traditional boundaries between public and private, intimate and extraneous'* (McCarthy and Wright, 2005). As an example, the authors cite *RIOT!1831* (Blythe et al., 2006): an interactive play which used mobile technology to connect participants with the past version of their environment. McCarthy and Wright claim that the participants enjoyed having a private experience in a public place, afforded by the nature of the phones' handheld form-factor. They also note the participants' appreciating being in the authentic environment, with them valuing being within the 'set' of the play. This concept could also be applied to Gerstmann's experiences with Google Earth VR, which elicited emotional reactions to visiting places from his life experiences in an 'authentic' (if virtual) place. Interestingly, Google Earth VR was also similar to *RIOT!1831* in that it allowed for private exploration and reflection in digitised versions of public places (e.g. being able to privately explore public streets which would ordinarily be crowded).

CrowdMemo was another project which used mobile technologies as a part of the place-making process (Balestrini et al., 2014). During the study, school children in Santa Fe, Argentina created video micro-documentaries using smartphones. These documentaries were about places and events important to the local community, and comprised of interviews featuring elderly people sharing their memories with the students. The documentaries were made available online, and accessible by scanning QR codes printed on commemorative plaques installed at places featured in the videos. From a place-making perspective, the researchers noted that the memories collected by the students were *'imbued with features of the local identity, and publicly displaying them led to reflection on locations in the town and why they are relevant to the community's heritage'*. One of the participants claimed that the created documentaries being personal and relatable (and arguably, as a result, more authentic) helped promote reflection: *'it's not about some texts and paragraphs put together by a historian, it's about the testimony of those who gave life to many of the situations in our heritage.'* The place-making impact of the project for local places of extended beyond the members of the immediate community, too: the school's headmaster noted that visitors to the town ask about the QR codes, and the community members use them to promote their culture at all times.

Balestrini et al. conclude the paper with some recommendations for HCI researchers conducting community technology projects, some of which may be helpful within a 'HCI for place-making' context. They recommend following action research principles: involving community stakeholders in the conception and running of the intervention and ensuring that it provides some value to each stakeholder. They argue that these were key factors in promoting a sense of community ownership over the project, with their stakeholders involved from the outset (to the point where the participants actually initiated the collaboration with the researchers). However, the authors note that a sense of ownership of the project would not have been enough to sustain engagement with it—they argue that this was achieved by providing value to all of the involved stakeholders (i.e. valuing the elderly participants' life experiences, giving the young students new technology skills, supporting the teachers in running an innovative educational project). Additionally, they recommend using existing, off-the-shelf technologies in novel ways, rather than introducing new, novel technologies. They note that many of their students already owned smartphones and therefore knew how to operate them, and were excited to be able to use these familiar devices in new contexts with a new set of skills. Reducing the skills barrier and the amount of new technical infrastructure required to participate helped make the project more sustainable. Balestrini et al. also suggest facilitating a range of face-to-face social encounters can lead to discussion and ongoing engagement. A given example is that the encounters between the children and the elderly participants was recognised as one of the most important elements of the project, as it

meant that the elderly participants knew that their life stories were being valued. This value of face-to-face encounters is echoed in Crivellaro et al's study, for which the technology probe's integration into the project was designed to encourage face-to-face interactions between participants with different life experiences.

Through the results of their 'Community Historians' project, Fox and Le Dantec explored how participatory technology design undertaken with communities could be better configured to support civic engagement and community empowerment (Fox and Le Dantec, 2014). They found that their initial approach was more in their interests as researchers than in the interests of the participants, who had been marginalised and particularly disillusioned with academia. In response, the researchers re-framed their workshops to be more clearly and immediately advantageous to the community members that they were working with. This involved both backing away from immediately pursuing their research goals and meeting with community leaders in order to identify ways in which the project could benefit the community members. In response to the community's negative past experiences with academic institutions and their concerns that they were once again being reduced to simple objects of study, the researchers even stopped referring to them as 'participants': instead, they were highlighted as collaborators through the use of the term 'Community Historians'. With input from the community leadership, the researchers held a series of design workshops exploring how the use and creation of technology could empower residents in the articulation and performance of community identity. The workshops featured 'Critical Making', where non-expert workshop participants had the opportunity to take a hand in the creation of device hardware from 'raw' components (e.g. camera sensors, motherboards). This was done as a means of promoting reflection about the potential usage of technology within the community, with the authors arguing that a DIY approach can give non-experts a fast-track to unpacking ideas for the potential uses of technology.

Fox and Le Dantec showed the Community Historians how to make portable cameras which automatically captured images upon detecting movement. However, some were uncomfortable using the cameras, as they were similar in function to the surveillance cameras used by the local authorities (who were seen as not having the community's interests at heart). This clash of researcher expectations with participants' reality is reminiscent of one of Star's projects (Star (1999), discussed in 2.2), where the project's solution was a poor match for existing infrastructures in the participants' workplace. The Community Historians project demonstrates that this can also occur with socio-economic infrastructures, not just physical and digital ones. This project was still successful thanks to the goals of the design process: rather than be 'product/technology-focused' encounters, the workshops explored what those encounters would have aimed to achieve and how those goals could be accomplished. Rather

than focussing on an end product, they worked towards identifying and developing processes to support community practices and empower them in *'in the face of authority and power differentials'*. The authors reflect that HCI design interventions in community contexts need to respect and engage the community on its own terms, acting as a *'balance against trends of rationalization and a rhetoric of disruption that underpin reductive moves to treat all communities the same.'* This argument falls in line with Relph's concerns about 'placelessness' (Relph (1976), discussed in 2.1), where he argues that by treating places (and, we can intuit, the communities which form around them and give them meaning) interchangeably or at too large of a scale results in 'inauthentic' experiences of place. Having a false or incomplete picture of a place's infrastructures can lead to inappropriate design decisions, as seen in Star's unsuccessful project. Fox and Le Dantec present a convincing argument for the fundamental advantages of truly participatory design: involve and emphasize the agency and perspective of community members from the outset, as they are the ones best positioned to inform the design process. As the authors posit: *'a mode of intervention that is based in community practice shifts the power to the community, so that it is not technology and data usurping local influence and ability, but instead technology and data selected in ways to support, preserve and amplify local influence and ability'*. In short, the researchers found that forming partnerships with communities and co-developing alongside them can be an effective way to encourage the articulation of an authentic shared community identity.

2.4. Digital Civics and the Spatial Citizen

Research held as part of the Digital Civics agenda frequently engages with the socio-economic relationships between communities and place. This section will give a brief synopsis of the Digital Civics agenda; how various Digital Civics projects have engaged with space, place and citizenship; and the concept of the 'spatial citizen'.

2.4.1. The Digital Civics Research Agenda

As a result of the economic crisis and resulting austerity measures enacted by the UK government over the last decade, many local authorities have been forced to implement severe cuts to their public services (including—but not limited to—waste management, transport, parks and recreation, education and social care). Olivier and Wright developed the Digital Civics research agenda at Culture Lab (later renamed to *Open Lab*, where this research took place) as a direct response to these developments, claiming that as a research group in a civic university (one which is *'embedded in, and responsive to, its local context'*) they were 'compelled'

to reflect on how their HCI research could be of use and value to the local authorities and citizens (Olivier and Wright, 2015). Prior to the Digital Civics agenda, Culture Lab's research had been human-centred and participatory, providing systems and services which were both meaningful and helpful. However, they reflected that their work had been detached from the local context—the research often *'failed to extend beyond the confines'* of their projects, meaning that it frequently could have been done anywhere. They also realised that they were only working within (and, as a result, proliferating) the status quo of service delivery from institution to citizens: they were giving people some input on the design of products, but in a way which still supported the framing of public services as being something 'done to' citizens without providing any alternative models. Digital Civics moves away from framing citizens as consumers and towards a model where citizens can take an active role within participatory systems, thanks to new forms of relationships between citizens, businesses and local authorities. Olivier and Wright admit that meaningful, systemic change such as this will take significant amounts of time. Even within the smaller scope of research projects, they posit that the development of long-term relationships between researchers, citizens and local authorities will be necessary if new relational models are to be realised and the potential roles for technology within them discovered.

On the Dangers of Libertarianism and the Impacts of Big Society

Before continuing, it is worth mentioning that Olivier and Wright note that there is also a danger of the Digital Civics agenda being warped or misconstrued as *'finding ways of making citizens do it for themselves, or dismantling public service provision'*. Digital Civics was imagined in the context of a period of austerity. As a part of this, many changes were put in place by the UK's conservative government under the guise of localism—part of David Cameron's 'Big Society' initiative which purportedly aimed to give local authorities the power to undertake local solutions to local problems, rather than continue to centralise power in Parliament. This agenda was ratified in the Localism Act of 2011, which de-regulated and/or removed many of the constraints related to local issues of housing and taxes (Ministry of Housing Communities & Local Government, 2011), and coincided with a number of austerity measures put onto public services and placing greater emphasis on volunteerism. While the principle of de-centralisation was seen as agreeable across much of the political spectrum, the 'Big Society' approach was met with public scepticism. Polls found that over half of respondents thought that the Big Society measures were 'just an excuse' to save money by cutting public services, and that only around 10% thought that Big Society would be a success (Ferragina and Arrigoni, 2017). Furthermore, while the restructuring put in place by localism measures relied on more pro-active and engaged citizenship from the public, some argued

that not enough resources were allocated to supporting this citizenship actually occurring. As Rogers argued at the time: *'Most of the political problems [the Prime Minister] faces, from cutting crime to reducing obesity, can only be met if residents and citizens play their part. Yet the state has so far invested very little in teaching the skills that could help people make a contribution'* (Ben Rogers, 2010). This lack of support meant that citizens who wanted to take advantage of the powers given by the Localism Act in areas such as town planning had to invest considerable time and effort, as their output was to be judged to the same level as professionals (BBC Sunday Politics, 2013). These expectations of large amounts of free time for research and volunteering would exclude many from the empowerment promised by the legislation, particularly those who had already been most impacted by cuts to social services and were likely to be time-poor.

It is within this context of volunteerism in the stead of well-funded public services that Digital Civics must walk a thin line: between supporting citizens living in the results of austerity and supporting the austerity measures themselves. While in some cases there may be a danger of Digital Civics projects being seen to re-configure the services provided by local authorities to enable a 'small government' model, this is is not the intention of the agenda (at least, as I have read it). This libertarian approach (in the contemporary and primarily American sense) is completely contrary to the motivations behind starting the research agenda in the first place: mitigating the damage done by conservative austerity politics upon public services. Instead, Digital Civics projects should aim to strengthen relationships between citizens and local service providers: instead of reducing the role government has within the lives of each citizen and relying on a 'DIY' approach, it should aim to empower citizens to have more involvement and agency within their government's processes. This key distinction means that rather than designing in preparation for the permanent loss of public services, Digital Civics technologies should work to mitigate hardships inflicted by austerity measures in a way which also implements improvements for when these measures eventually come to an end.

2.4.2. Digital Civics and Place

There have already been several projects within the scope of the Digital Civics agenda which are related to the use of technologies within space and, more importantly, place. While each of these projects addressed this agenda, each took a different approach to highlighting and utilising elements of place.

PosterVote

The PosterVote project (Vlachokyriakos et al., 2014) explores how low-cost technologies could be utilised by communities to support grassroots democracy and social action. The system consists of a low cost, lightweight piece of hardware, stuck onto the back of a piece of paper. A question and up to five responses is printed onto the paper, with each response having one of the hardware's buttons underneath. The system simply records users' choices, which can be reported back through a machine-readable series of LED flashes and beeps.

The motivation behind the project stemmed from how most uses of technology for civic engagement (e.g. showing discussions on public displays) frequently require technical knowledge and are 'mostly initiated or managed by local political organizations and local councils'. As a result, these institutions are still the ones driving agendas, and usually only using these technologies as consultation tools to increase perceptions of efficacy. Vlachokyriakos argues that the high cost and top-down nature of these systems make them 'inappropriate for activism'. Similarities can be drawn between these existing civic engagement technologies and mobile learning—creating new, bespoke mobile learning technologies and experiences can require significant technical knowledge, and commissioning the creation of one frequently incurs significant costs. As a result, bespoke mobile learning technologies are largely out of reach for most community-driven organisations.

PosterVote was designed to support the diverse viewpoints of activists and stakeholders by removing the need for technical skill and significant funding. Furthermore, the nature of the design harnesses different engagement levels of people within communities: individuals who are the most engaged and are willing to put more effort into a project may choose to set up their own PosterVote instance, while less engaged members can simply use the devices to share their views or make use of the data others have collected. This kind of approach is how many groups of place volunteers function: more engaged members helping to maintain a place, whilst less engaged members of the community take a more 'consumer' role. As such, it's easy to imagine a similar approach also working with regards to digital representations of place through mobile learning technologies.

The authors note that the low cost of the posters initiated discussions about their ownership: some participant groups treated the deployments as an effort to be owned by the community (without making any real distinction between the posters' organizers and the wider community), while others were cautious about democratising the process too far and kept a more rigid hierarchy. Such questions of ownership are likely to be raised in this project too, particularly in regards to wider communities being able to share their interpretations of

place, which may clash with the views of the owner/controlling body of the corresponding space.

Vlachokyriakos et al. also report that one of PosterVote's main advantages is that is can operate within relevant space and place—the nature of the technology means that it can be placed in a location relevant to the question being asked, and that people's participation with the system can be configured according to where and how it is deployed. Participants noted: '*The thing about having it on a lamppost is it's directly relevant to that particular position.*' While there is likely a value in such a technology being static in place (e.g. a concrete association between it and the space in which it resides), mobile technologies would also have the advantage of being able to traverse between different contexts, allowing for similar levels of relevancy to multiple places.

FeedFinder and App Movement

This potential of mobile technologies to be utilised by users to share their opinions of place has been explored in two other Digital Civics projects: FeedFinder and App Movement.

Designed as a response to a perceived lack of practical and moral support for breastfeeding in public spaces, FeedFinder is a smartphone application designed to support breastfeeding women in finding, reviewing and sharing public breastfeeding-friendly places (Balaam et al., 2015). The application allows users to add locations such as businesses to a map and review them based on relevant categories. Reviews are public, meaning that others can see how places have been rated to make more informed decisions about where they choose to breastfeed. Some women even used the system to try and effect change: for example, one participant showed the application to a department store's manager, comparing them to a competitor's ratings as a way to get them to improve their facilities.

FeedFinder served as a tool that facilitated the collection and sharing of '*lived experiences*' of breastfeeding in public, and the comparison of these experiences on a local, regional and national level. This supported participants in not only finding more comfortable places to breastfeed, but also provided a way to compare lived experiences to the presumed rationality: that the public is not supportive of breastfeeding in public. These surfaced lived experiences acted as evidence for publics who wanted to effect civic action and real social change. This also highlights another possible area for investigation in this research project: how place-based mobile learning technologies could be used as a method for civic action by stakeholders as a part of meeting their own agendas.

Following on from FeedFinder, AppMovement is a platform which enables the promotion, design, production and deployment of community-commissioned mobile applications (Garbett et al., 2016). Using a website, users are able to propose a idea for a location-based review mobile app (e.g. "Safe places to fly your drone"), each functionally similar to FeedFinder. Communities can commission similar applications, bespoke to their own contexts and requirements. As well as the place review data within each app being community generated, the applications themselves are proposed, produced and promoted by their own community of interest. As such, App Movement extends the 'grassroots', community-contributed nature of FeedFinder into the production of the application itself.

Garbett et al. note that many communities of interest had already demonstrated that they're capable of (re)appropriating technologies for their own purposes, but issues of cost and technical know-how frequently prevent them creating their own bespoke solutions. As noted earlier, the same can be said for volunteer-based organisations caring for community spaces. In response to this, App Movement makes an effort to democratise the creation of mobile software: serving as a blend between PosterVote and FeedFinder, it lowers the cost and technical requirements of producing technologies which can be used by communities for their own requirements, independent of top-down institutions. As touched on by Vlachokyriakos et al. in the PosterVote project, the authors note that this 'community DIY' approach led to a sense of ownership and stronger engagement: '*Proposing an idea leads to a sense of ownership of it. The result of this sense of ownership is the increased motivation to promote the concept and engage the community in the appraisal of the idea.*'. Furthermore, they argue that the democratising of the app creation process opens it up for appropriating by communities, allowing them to '*more accurately address [the] issues they face*'. These projects highlight the potential for place-based technologies to foster a strong engagement with communities by giving them approachable creation tools: technologies which give enough creative freedom to support communities in addressing the issues they care most about.

WheelieMap

WheelieMap is another Digital Civics project which explores how digital space-based technologies can support civic advocacy (Kirkham et al., 2017). The platform is designed to support wheelchair users in identifying, documenting and reporting areas which have accessibility issues by recording and uploading a combination of motion data, video clips and GPS location data. When combined with qualitative user reports, the system can empower wheelchair users to map inaccessibility and advocate for improvements. This approach improves on existing solutions, which frequently rely on expert documentation (which is

expensive), purely automatic systems (which lack qualitative assessments) or 'offline' community efforts (which frequently lack actionable evidence for decision makers).

When reflecting on their experiences with the system, some participants noted that it offered a potential for sharing their point of view and assisting in empathy with the wider public. In this context, the technology was used as a tool to assist in communicating to others the participant's interpretation of place (particularly the infrastructures within it, such as paths), and how it could be improve. Unlike App Movement, WheelieMap is limited to the single context of accessibility. However, it acts as an example to how place-based mobile technologies can highlight others' experiences and interpretations of place, and how such submissions could be used as educational resources and for civic action.

Data:In Place

Data:In Place is a web platform designed to support the open access and sense-making of data for the purpose of civic advocacy by citizens, enabling effective action in relation to place-based issues and concerns backed by relevant data (Puussaar et al., 2018). Rather than focusing on community-generated content as with the previously discussed projects, Data:In Place instead explored how interpretations of place could be explored or evidenced through providing easy access to existing data.

The authors worked with a group of residents interested in starting a Neighbourhood Plan, a process introduced through the Localism Act as discussed earlier. The Data:In Place platform supported these citizens in using data as evidence for their civic action. Previously there had been technical and knowledge barriers in place which had distanced them from using it effectively, relying on third-party professionals and raising issues around dependency, economic exclusion and misrepresentation. The authors argue that being able to easily access data through the platform also supported participants in exploring local issues and more deeply understanding their communities: demonstrating how digital technologies can be used to gain and share deeper understandings of local issues and interpretations of place.

ThoughtCloud

ThoughtCloud is a feedback system, designed to be deployed in situ where voluntary and community care organisations deliver their services (Dow et al., 2016). The system supports both quantitative and qualitative feedback, through the use of Likert scales and the recording of video and audio messages. Suggestions for feedback topics can be configured by the

event organisers by them supplying a set of questions. ThoughtCloud was motivated in part by the fact that stakeholders who use and rely on certain services are frequently under or misrepresented in existing feedback pipelines, with reasons ranging from stigmatisms of particular services to tokenism.

One of the study's findings was that while some of the more structured responses were of limited use (due to the participant being overtly guided by a third party or a leading question), some of the more unstructured qualitative data was seen to provide '*richer accounts of personal experience of the provided services, and how people saw themselves as members of a community.*' This suggests that participant-led free-form audio and video recording could be a good medium for gaining insights into stakeholders' relationships with the social infrastructures they engage with, and how they position themselves within a community.

Community Conversational

Community Conversational (Johnson et al., 2017) is a Digital Civics project with direct ties to the issues surrounding the UK government's localism measures. The project focuses on consultation engagements with local residents held by community organisations and local authorities. These organisations had a responsibility to involve local residents in consultations and provide evidence for both the fact that these engagements took place, and that the views and opinions raised by residents were being taken into account in the decision making process. In keeping with the increasing reliance of volunteerism due to cuts to local authorities' funding, running these engagements had become the responsibility of volunteer-based organisations. The researchers identified that these consultations frequently failed to capture rich insights from participants due to numerous issues, including volunteer groups lacking the resources and research experience necessary to effectively capture and analyse data. In response, Johnson et al. produced Community Conversational—a workshop activity which took the form of a board game, augmented with video recording and an online data repository. Game pieces could be placed on a map, with the system tracking their placements and matching them with recorded audio.

While the participants valued the more open nature of the conversation—thanks to it not '*being bound by and driven by council officers*'—the decision making facilitators struggled to make use of the more more open qualitative data. The researchers noted that despite the collected data being 'rich', the decision makers saw it as being of limited use, having previously aimed to collect quantitative results as evidence of support for previously identified solutions to a given issue. The authors argue that this points towards the organisations recording the

opinions of local experts as a tokenistic series of bureaucratic tick boxes, rather than including them in meaningful consultations. This was further evidenced by the council representatives using the data purely in relation to predefined issues, limiting the practical value of a rich data set. Comparing the findings of Community Conversational with those of WheelieMap and ThoughtCloud makes it clear that even if consultation participants are contributing rich insights about their use of space, the value institutions take from participants' shared interpretations of place is limited by the way they are analysed and responded to. I argue that such findings highlight the need for platforms outside of such institutional control, through which stakeholders are able to share their values and concerns regarding place with others without the need to go through institutional filters.

Gabber & TalkFutures

Gabber explicitly aims to tackle this issue by supporting stakeholders in contributing directly towards the collection and analysis of qualitative data (Rainey et al., 2019). The Gabber mobile app supports users in collecting spoken audio data, with participants responding to pre-defined prompts written by the research coordinators. Participants can either record themselves or others responding to these topic prompts, supporting qualitative data collection which is distributed, large-scale, low-cost and participatory. With the interview participants' explicit consent, audio recordings are then made available on the Gabber website for others who have been involved with the project to listen to, highlight, tag with themes and comment upon. In this way, stakeholders partaking in public engagements are able to contribute throughout the entire process, and are given more transparency around how their data is being used. As a part of a different research project, I helped produce a fork of Gabber, called TalkFutures (Rainey et al., 2020). TalkFutures was developed as a component of Strategy 2030, a research project within the International Federation of the Red Cross and Red Crescent which aimed to understand the issues and challenges which the Federation would face in the near future. As with Gabber, TalkFutures made it easy for participants to contribute semi-structured, qualitative audio data (e.g. in the form of interviews). Uploaded audio recordings were made available on the TalkFutures website, where they could be filtered by discussion topic or even which National Society the participants worked in. By the conclusion of the Strategy 2030 investigation, members from 86 different National Societies contributed recordings using the application.

The approach taken by Rainey et al. in both Gabber and TalkFutures is reminiscent of Fox and Le Dantec's 'Community Historians' project (discussed in 2.3.3), in that stakeholders contributing to the research are treated as collaborators rather than participants. While

Community Conversational encountered institutions simply engaging stakeholders as a sort of tokenistic gesture to justify previously made decisions, the collaborative structure of Gabber almost precludes that—stakeholders are able to see each others' data, contribute to its analysis and hopefully more easily understand how the researchers reach their final conclusions. These projects highlight that including stakeholders to give creative input throughout an engagement process is key to gaining the richest understanding of issues within place. Furthermore, it demonstrated how giving greater levels of control to place stakeholders (without interference from top-down institutions) can result in greater levels of transparency and perceived authenticity.

Remix Portal

Remix Portal is a web platform designed to connect schools with musicians within the local community through the teaching of music remixing, utilising local communities as educational resources (Dodds et al., 2017). The tool is used within school music lessons, allowing children to place effects and mix the individual instrument stems of given tracks created by local musicians. After remixing, children are given 'show and tell' feedback through the web portal fellow students, teachers, or—most significantly—the original musicians. As a result, Remix Portal provides a platform upon which schools are able to directly connect with local experts within nearby communities. This gives students a greater appreciation of their local music scene, as well as a realisation that it was possible to create great creations without needing to have the opportunities given to the biggest stars. As one student noted: '*Everyone expects it to be the big famous people that you listen to, but we've got people living nextdoor to us that are just as good.*' The students were also particularly motivated knowing that the original musicians would listen to their remixes, as they wanted to 'impress them'. The experts also claimed to benefit from the study from exposure to new audiences, inspiration from the students' submissions and even the opportunity to 'pay back' teachers who had previously nurtured their talent.

Remix Portal demonstrates that it's possible for learning technologies to introduce new layers of infrastructure for local knowledge sharing. By taking part and being exposed to local talent and expertise, the students were able to reflect and re-evaluate their interpretation of place within the context of music production—not only highlighting community expertise which they may have previously been unaware of, but also potentially opening new interests and hobbies for the students to further explore. Remix Portal demonstrates that learning technologies can help bridge formal education contexts with local communities of practice,

resulting in students having a greater appreciation of the value of places close to them. Such findings highlight the potential for mobile learning technologies to do the same.

2.4.3. Spatial Citizenship

Outside of the Digital Civics agenda, Gryl and Jekel argue for a greater utilisation of geo-information systems (GIS) in secondary schools (Gryl and Jekel, 2012). They argue that common reasons for including GIS within schools—such as preparing students for entering the workforce by introducing them to technical tools (which are often outdated by the time students enter industry), or that spatial thinking is a key competence for problem solving across multiple subjects (with 'spatial thinking' usually being very narrow and limited, not accounting for social elements such as human intent, power and political processes)—are misguided or limiting.

Instead, Gryl and Jekel argue that 'spatial citizenship' is their preferred approach for including GIS in secondary education. Rather than configuring the use of technology to prepare students for entering the workforce or meeting scientific requirements, spatial citizenship is centred around the everyday lives of individuals. They claim that education for spatial citizenship '*aims at enabling secondary students to devise alternative spatial scenarios, and to participate competitively in society.*' Gryl and Jekel argue that such an education is necessary to prepare students to be active 'spatial citizens': those who are able to use GIS to *'critically appropriate space by democratic means in order to participate in society.'* In short, it's teaching students how to use spatial data to be citizens, rather than simply workers. The goals of spatial citizenship education—and a comparison to previously existing models of citizenry—can be seen in Table 2.1. In order to fully participate in society, the authors argue that learners should be able to access, read, interpret and critically reflect on information surrounding a space, as well as express and share their own location-specific opinions. Gryl and Jekel argue that citizens' access to and understanding of data can be a society-changing factor: they posit that data can be used to exercise control over others or work towards solving the world's problems, and that the absence of it can allow for such problems to be neglected or hidden—particularly with the construction of 'alternative facts' (Gryl and Jekel, 2018).

The links to the previously discussed Digital Civics projects are obvious—under this context, there is a clear scope for the concept of the spatial citizen to play a role in local knowledge sharing and exposure to existing communities (e.g. Remix Portal), collecting opinions within given areas (e.g. PosterVote), platforming stakeholders' opinions on given topics (e.g. Gabber, Community Conversational, ThoughtCloud), providing data as evidence for advocacy (e.g.

Data:In Place, WheelieMap) or the creation of new GIS technologies to meet a community's specific needs (e.g. FeedFinder, AppMovement). An important aspect of civic education is giving the learner the skills and knowledge necessary for active involvement in society, through information sourcing, critical analysis and debate. Highlighting the importance of active citizenship, Walzer claims that *'the passive enjoyment of citizenship requires, at least intermittently, the activist politics of citizens'* (Walzer, 2008). Spatial citizenship allows for the re-contextualisation of the above projects into the field of education, exploring how the development of active spatial citizens can be supported through the use of place-based technologies. Furthermore, it highlights under-explored opportunities for 'civic mobile learning': where mobile learning technologies incorporate some or all of the dimensions shown in Table 2.1 to encourage or introduce learners to active spatial citizenry.

Dimension of citizenship	*Dutiful citizen*	*Web 2.0 citizen*	*Spatial citizen*
Knowledge	National history emphasizing common experiences and myths; government functions.	Generational histories emphasizing life experiences; finding and assessing credible sources of information outside the official domain.	Spatial embeddedness of social life; constructions of space and deconstruction methods of spatial information.
Organisation	Knowing about lobbying, parties, civic groups; reasons to join these.	Role of social networking, reasons to and effects of joining social networks.	Geo-communities; effects of everyday application of GI; spatial privacy issues.
Communication	Understanding conventional media.	Participatory media skills (e.g. blogging); learning how to reach audiences with digital media.	Participatory geo-media skills: competitive lay mapping, volunteered geographies, learning about the power of maps.
Participation	Voting, campaigning and courts of justice.	Identification of paths to join or organize effective peer advocacy networks.	Identification of paths for spatial analysis and representation in decision-making processes.
Attitudes	Trust in government and institutions of the state.	Empowerment, trust in networks, confidence in participatory skills.	Habit of reflection on own and others' spatial constructions, confidence in participatory skills regarding spatial planning.

Table 2.1 Gryl & Jekel's spatial citizen, compared to the education of other models of citizenship such as the 'Web 2.0 actualised citizen' (Gryl and Jekel, 2012)

2.5. Summary

This chapter briefly introduced the concepts of space, place and infrastructure, as well as some of the HCI research that has been undertaken to understand how technologies might influence the place-making process.

Place and space are different—albeit related—concepts: while space might describe a geographical area which our bodies can perceive, place is much more abstract, describing the meanings that individuals ascribe to physical or abstract (e.g. online) spaces. Space and place also feature layers of physical and social infrastructure, which can be interpreted on a similarly personal level and can shape how individuals experience place. For these reasons, place-based technologies need to at least be aware of the personal nature of a place, as people's experiences, relationships and interactions with it can be jarringly different.

Our relationships with places are built through experiences with them over time ('place-making'), however the nature of these experiences can change how the relationship develops. A person might subconsciously experience place remotely through seeing it in movies ('vicarious insideness'), or deliberately attempt to understand a place in-depth through more thorough investigation ('empathetic insideness'). Furthermore, these representations of place may be deliberately or inadvertently sanitised, leading to an inauthentic experience of place. Place-making is frequently defined as being made up of two complementary concepts: place attachment (the degree to how much someone values or identifies with a place, from it fulfilling their needs or defining them as an individual) and place meaning (the meanings that individuals ascribe to settings that they are familiar with, reflecting their environment, social interactions, culture, politics, economics and history).

As place-making occurs through *experiencing* place over time, technology is able to influence the process. While frequently derided as elements that distract from experiencing the real world, digital technologies such as smartphones also provide new place-making opportunities by opening up access to new media formats, discourse and information and places near and far. Technologies have already allowed people to share their personal experiences with and knowledge of place with others, supporting new avenues for building vicarious and empathetic insideness through the sharing of place meaning. HCI Researchers have repeatedly emphasised the importance of working closely with stakeholders, through co-design and action research methods. Working closely with local stakeholders can grant insight into personal stories and individual interpretations of place and infrastructure, minimising inauthentic representation and inappropriate design. Researchers have also noted the im-

portance of providing value to the stakeholders they work with, and that giving stakeholders a degree of ownership over the project notably increased meaningful engagement.

Existing Digital Civics projects have supported and empowered place stakeholders with new methods for knowledge sharing, self-representation and the expression of their needs and values—all of which could be utilised in the place-making process. Gryl and Jekel's 'spatial citizen' provides an opportunity to re-frame technologies designed to promote place-based citizenry to the field of education. These projects highlighted: the value of engaging with place while in authentic contexts; that digital technologies can highlight others' experiences and interpretations of place, as well as communities of practice, as educational resources; the value of giving communities significant degrees of creative freedom and approachable tools; and a demand for technology to empower place stakeholders in self-representation and civic action without contributions first being filtered through top-down institutions. I identified an under-explored opportunity for technologies to offer 'civic mobile learning': experiences within authentic learning contexts, which introduce learners to new interpretations of place, communities of practice and opportunities for active citizenry.

Chapter 3. Civic Mobile Learning: Theory and Practice

One of the aims of this project is to explore the use of mobile learning technologies as tools for learning in—and promoting building relationships with—authentic space and place. This chapter gives an overview of the previous research that has been conducted concerning mobile learning. The learning theories of constructionism and project-based learning are also covered, as they are particularly important to the research discussed in Chapter 8.

3.1. Civic Learning in Space and Place

The importance of space and the context of place in educational processes is a well-researched subject. Dewey recognised the educational potential and underuse of physical and social environments outside of the classroom in 1938, noting that the physical, historical, occupational and economic conditions of the local community could be utilized as learning resources (Dewey, 1938).

In addition to the previously discussed concept of 'spatial citizenship' (Gryl and Jekel, 2012), this project also works within the more general concept of what I have labelled 'civic learning': that which supplies the learner with the knowledge, skills and values they need to be citizens who actively participate in their local communities and take responsibility for improving and understanding them. I argue that civic learning is an essential component in educational systems wishing to promote active citizenship within society. For example, the most applicable subject within the UK, 'Citizenship Education', has shown to have positive influences on political efficacy, participation, involvement and knowledge (Whiteley, 2012). Despite this, however, it has been demoted within the UK's Department of Education to an optional subject as a part of the Basic Curriculum (Education, 2011). Citizenship Education is now recommended to be included within other curriculum areas rather than as a distinct 'subject', despite previous findings showing it had already suffered from delivery by non-specialist teachers and being treated as a second-tier subject due to its lack of formal assessments (Burton and May, 2015; Ofsted, 2013). Burton even speculates that this neutering of civic learning

in the UK may be a deliberate action by policy makers to avoid encouraging democratic debate, freethinking and '*engendering extensive controversy and potential anti-establishment action*' (Burton and May, 2015). While this is somewhat alarmist, it's not unlikely that a lack of quality civic education would impact students' future roles as active citizens—further highlighting the educational importance of Digital Civics (and the adjacent concepts, such as spatial citizenship education) and how digital technologies can play a role in preparing students for their futures roles as citizens.

This thesis explores how engaging with the social infrastructures of place as learning resources could assist with this process. Such engagements would likely benefit from being situated within those places—Lave and Wenger's Situated Learning Theory posits that learning is normally situated: embedded within activities, contexts and cultures (Lave et al., 1991). They argue that social interaction and collaboration become essential for the learner to assume a role of expertise, by moving from the periphery to the centre of 'communities of practice' (a group of people either virtual or in-person, who share a craft, profession or common interest) through 'legitimate peripheral participation'. This participation for newcomers could initially consist of simple, low-risk tasks which further the goals of the community. As the newcomers gain experience and are recognised for their mastery of tasks, they move towards to the centre of the community and become 'old-timers'. Lave and Wenger argue that collaboration and social interaction are essential components of learning which lead to learners entering a relevant community of practice. This ideal is in clear contrast to more traditional classroom activities, where knowledge commonly isn't presented in authentic contexts. As such, Situated Learning Theory places emphasis on legitimate peripheral participation in communities of practice, focusing on the relationship between learning and the social situation in which it occurs (Lave et al., 1991). It follows that meaningfully engaging within these communities can also be framed as a place-making process: it exposes learners to others' interpretations of place, as well as encouraging them to develop their own interpretations through the growth of new relationships with existing communities. Furthermore, it means that for a large number of subjects and communities the classroom is not an ideal learning environment.

That said, formal education contexts such as classrooms are not totally incompatible with place-based learning—as shown in the previous chapter through the discussion of projects such as Remix Portal, communities can be a significant source of knowledge and expertise, often underused by formal education systems (Dodds et al., 2017). Communities can also actively create new learning material: to encourage the capitalisation of local knowledge, Leat argues for the introduction of community curriculum making (Leat, 2015). This involves a portion of a school's curriculum being developed alongside community partners and making use of community resources. Leat claims that not only do students find working alongside

community members to be more compelling and engaging, but that exposure to these new individuals can also provide new opportunities for identity development. As with the contrast between the ideals of situated learning and the classroom-based reality, Leat notes that the current curriculum-focused schooling system is configured in a way that creates strong pressures to 'teach to the test'. He argues that this has created a gulf between in-school and out-of-school learning, with schools introverting and over-emphasizing the value of 'official' curricula, pedagogy and assessments. As a result, schools aren't fully engaging with local resources, opportunities, issues and needs—removing opportunities for students to discover and enter nearby communities of practice. Such research highlights opportunities for this project to engage with community expertise, both inside and outside of the formal classroom context. However, there exists a danger of simply framing local experts as taking a fairly passive role with regards to knowledge sharing—a knowledge resource to be sapped, rather than stakeholders with their own motivations and agendas.

Engaging with properties of physical space as educational resources has also gained popularity within the last few years. Outdoor learning (also commonly referred to as 'learning outside the classroom' (Lotc.org, 2006)) is an experiential approach to learning which develops personal, social and environmental understanding and skills, with outdoor environments being core to the experience (Harvey, 2012). While outdoor learning activities don't always class as situated learning (for example, 'Computer Science Unplugged' takes place outdoors in a playground, instead of the 'authentic context' of a computer development environment (Bell et al., 2009)), the two are clearly intrinsically linked when the subject matter concerns the lcoal environment. The benefits of outdoor learning have been extensively researched and recognised: in their 2015 review of the evidence base surrounding outdoor learning, Fiennes et al. found that many papers reported that outdoor learning activities had consistently positive effects on everything from children's academic performance to social skills and self-image (Fiennes et al., 2015). The UK government's Office for Standards in Education, Children's Services and Skills (Ofsted) noted that '*Learning outside of the classroom contributed significantly to raising standards and improving pupils' personal, social and emotional development*', finding that '*Hands-on activities led to improved outcomes for students, including better achievement, standards, motivation, personal development, behaviour [and] positive effects on young people who were hard to motivate*' (Ofsted, 2008). As a result, they labelled outdoor learning as an essential element of a broad and balanced curriculum.

3.2. Mobile Learning

Mobile learning (m-learning)—which Crompton et al. define as '*learning across multiple contexts, through social and content interactions using personal electronic devices*' (Crompton, 2013)—has been increasingly of interest in HCI due to the growing abundance of mobile devices. The portability and networking capabilities of these devices has been shown to be of great potential for educational applications: not only allowing users to access online learning materials irrespective of time and place, but also allowing m-learning applications to take advantage of the user's physical environment to enhance the learning experience (Frohberg et al., 2009). The adoption of mobile devices into UK classrooms has been dramatic, with nearly half of UK schools being expected to have one tablet per child within the next few years (British Educational Suppliers Association, 2015). While traditional desktop and laptop devices are currently still more common in schools (British Educational Suppliers Association, 2017), mobile devices have been touted as having a number of advantages over their more stationary counterparts, such as offering structured educational experiences which can be situated in—and responsive to—authentic learning environments (Traxler and Wishart, 2011). This makes mobile learning well suited for situated learning practices. Previous m-learning research has used these capabilities for a wide variety of applications, such as sensing tool kits to conduct citizen science (Sharples et al., 2017); enabling seamless learning across classrooms and museums on school trips (Vavoula et al., 2009); and empowering children in collecting evidence to support their advocacy and engagement in urban design processes (Peacock et al., 2018).

3.2.1. Activity Theory and the Task Model for Mobile Learning

A variety of social and environmental resources and influences must be considered when designing mobile learning activities, due to the portable nature of the devices they inhabit. Activity Theory has long been used as a framework through which the impacts and interactions of a variety of factors affect an activity's process and results (Figure 3.1). The second generation of the framework describes a system for performing an activity—where a subject (e.g. a student) works on an 'object' (e.g. a book report) in order to obtain a desired outcome (e.g. a completed review of a book for class), using tools and 'instruments' which can be internal (e.g. prior knowledge) or external (e.g. online resources) (Leont'ev, 1978). In order to consider multiple people working on the same object, Engeström extended the framework by adding a 'community' component, featuring 'rules' (explicit and implicit definitions of how subjects should fit into the community) and 'division of labour' (how the activity's object

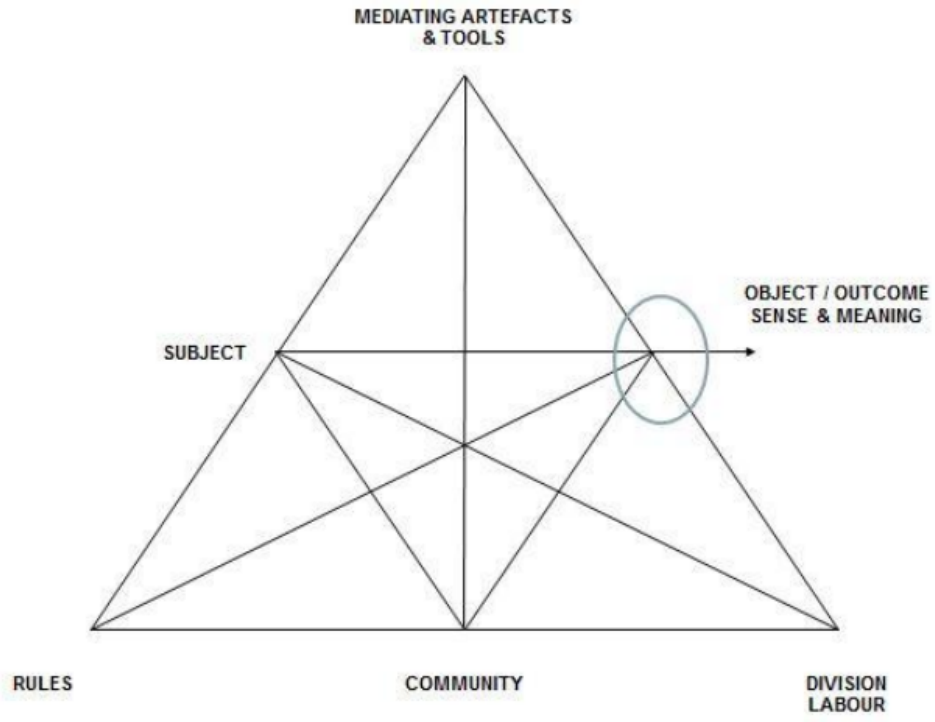

Figure 3.1 The second generation of Activity Theory (Engeström, 2015; Leont'ev, 1978). The third generation combines multiple of these triangle models through a potentially shared object (Engeström, 2001)

relates to the community) (Engeström, 2001). Engeström's third generation of Activity Theory represents the multiple perspectives of community members through the binding of multiple of these activity systems over a common object. As a result, this version of Activity Theory has become a valuable tool for analysing the processes of activities undertaken by individuals and groups.

However, this version of the framework still lacked the means to describe some of the factors involved when performing educational activities in space and place. With the aim of constructing a framework suitable for mobile learning, Sharples and Taylor extended the third generation of the framework further, creating a task model for mobile learning (TMML) which placed new emphasis on previously overlooked factors: context, control and communication (Sharples et al., 2007; Taylor et al., 2006) (Figure 3.2). In this model, 'context' refers to the learning environment (an important factor, considering the portability of mobile learning systems); 'control' refers to the amount of scaffolding and moderation placed upon the learning activity; and 'communication' describes the user's interaction with other learners. Activity Theory's subject, object and tool are still present, describing the learner, the learning object and what they will use to assist in that learning respectively. As this model allows for

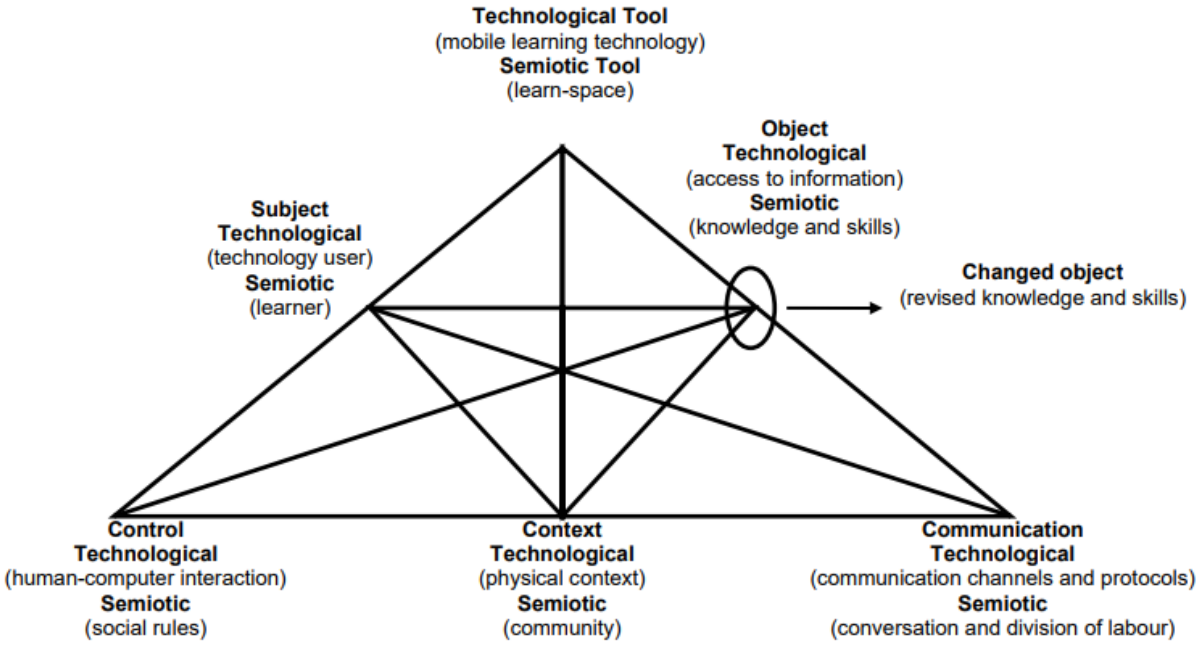

Figure 3.2 The Task Model for analysing Mobile Learning (Taylor et al., 2006). Expanding upon Activity Theory, it adds Control, Context and Communication as additional factors to consider when designing for mobile learning.

the description of any mobile learning project in a structured way, comparisons between different projects are possible.

Using the TMML, Frohberg et al. performed a critical analysis of mobile learning projects existing prior to 2008 which, while technologically outdated (the projects largely exist prior to the widespread popularity of smartphones and the proliferation of mobile apps through digital storefronts), still provides numerous applicable insights for design (Frohberg et al., 2009). The authors produced their review of existing projects by analysing them according to each of the TMML's factors: context, tools, control, communication, subject and object. Below is a brief overview of the discussions held by Frohberg et al. on each of the factors, as well as insights from other research.

Context

Frohberg uses *Context* to describe the relationship between the learning context and the learner, placing activities into four categories: independent (when the learner's physical/social environment has no relationship to what they are learning), formalized (a formal education, classroom-like setting), physical (the learning takes place in a space relevant to the learning topic—the learning is physically authentically situated) and social (subjects

learn through sharing sustainable relationships with others—e.g. entering a community of practice).

Many of the projects examined by Frohberg et al. were found to exist independent of the learner's context. A modern example could be the educational website Khan Academy, which aims to '*provide a free, world-class education for anyone, anywhere*' (Khan Academy, 2011). As Khan Academy is location independent, it can't take advantage of the learner's current surroundings as an educational resource. Frohberg et al. noted that those projects which *were* context dependent tended to rely upon and make use of the physical properties of the learning environment: for example, the Ambient Wood project uses the physical context to provide learners with contextually-relevant digital information during their exploration of the environment, provoking reflection and discussion (Rogers et al., 2004). In contrast, few projects engaged in a 'socializing' context, in which learners share relationships, emotions, values or personal history. Other examples can be found in mobile learning literature—for instance, while MOBIlearn attempts to incorporate the learner's spatial and temporal contexts within a museum, it doesn't engage with the social context: the museum's role in the surrounding communities and the relationships it shares with their members (Lonsdale et al., 2004). One potential example is the Talking Statues project, which provides a passive civic learning experience by exposing the learner to underlying place meaning and local knowledge through audio-based augmented reality: nearby celebrity-voiced statues 'phone' the learner to inform them about local histories (Sing, 2017). Javornik et al. argue that augmented reality applications (particularly visual ones) have the potential to enhance mobile learning experiences, as they can connect the physical and digital learning contexts (Javornik et al., 2019).

Tools

Tools is the term used in the TMML to designate any material, medium, device, instrument or artefact that is used to mediate the learning process. For their critical analysis, Frohberg et al. produced a scale describing the learners' tool usage—from a passive, content consumption mode of learning on one end, to content construction on the other. They argue that while more passive learning tool usage is often more efficient for teachers (as content can be pre-prepared for delivery and can be easily assessed), it offers a cognitively passive learning experience through which the learner is unlikely to gain much more than a low-level of understanding and applied knowledge. In between these extremes lie simple interactions for motivation (such as quizzes), guided reflection through situated tasks to reflect upon, and reflective data collection, in which learners explore an environment to collect their own data.

Frohberg et al. found that many of the analysed mobile learning projects provided extremely passive learning experiences, delivering content to the user which offered little to no creative control over their learning or output. The authors noted that projects which leaned towards the learner constructing content (rather than passively experiencing existing content, such as video, written articles, podcasts or—to a lesser extent—multiple-choice quizzes) offered the learner a deeper understanding through reflection. Chan et al. argue that the delivery of simple 'instructional content' results in the learner being regarded as simply a consumer of product, ignoring the high pedagogical value of active, productive, creative and collaborative learning (Chan et al., 2006). Examples of activities that have tools which promote reflection through creativity include solving the open questions found within digital mysteries (Kharrufa et al., 2010), and children's creation of digital 'hidden stories' to be shared with others (Wood et al., 2014). Passive delivery of content is unlikely to provoke deep learning and civic engagement: as with Gryl and Jekel's technologies for spatial citizens, effective civic technologies should allow learners to actively engage in dialogues surrounding places' meanings and social infrastructures, rather than act as a simple information delivery system (Gryl and Jekel, 2012). This also highlights the passive nature of projects such as the previously discussed Talking Statues, which I argue limits their potential for place-making due to the learner's lack of meaningful participation. One way to further embrace the social context of the statues could be to have users contribute their own interpretations and stories relating to place. Such technologies could be suitable for the sharing of place meaning and empathetic place-making.

Control

The TMML adds *Control*, which describes the balance of responsibility between the teacher and the learners for the learning process and setting targets. As with Tools, Frohberg et al. placed the projects they analysed on a spectrum, from tight teacher control to full learner control. They note that while full teacher control is efficient for delivering specific content, it offers learners very little responsibility, impacting motivation and introducing the danger of learners 'doing the motions' without deep understanding of the content. However, they argue that the opposite end of the scale also risks over-straining learners, with a lack of oversight potentially leading to disorientation, missed learning goals, frustration or the development of false conclusions. As a result, Frohberg argue that somewhere between the two would be preferable, with a degree of scaffolding or direction still being required in most cases. Land similarly stresses the necessity of scaffolding and offers multiple other mobile learning design guidelines, including supporting a range of learner ages and reading abilities through visually varied interfaces (Land et al., 2015). Frohberg et al. found that few of the mobile

learning projects they analysed were positioned in this ideal scaffolding range, with most having overbearing teacher control and a few having less learner-orientation than would be ideal. They note: '*very few mobile learning projects with physical context explicitly considered, positioned or focused the usage of mobile technology as instruments to gain transparency and steer flexible learning activities there*', arguing that achieving the full potential for m-learning technologies may require allowing learners more space and freedom, whilst still offering a degree of guidance.

Communication

Representing the 'community' element of Activity Theory, *Communication* in TMML refers to if and how the learner works with others during the learning process. Frohberg et al. argue that reflection can be encouraged by learners working together, identifying and filling each other's knowledge gaps to achieve deeper learning. The authors again place the degrees of communication found in each project on a scale. The extreme low end of this scale features isolated learners who work independently with the learning material and given tools (for example, Khan Academy users individually work through set curricula (Khan Academy, 2011)). Following this are 'loose pairs' of students, who work on the same device or learning material, but the learning scenario doesn't explicitly require them to cooperate—students who are specifically asked to work together and discuss a piece of work are instead in 'tight pairs' (e.g. the Digital Mysteries project asked students to collaborate on a task in small groups using table-top interfaces (Kharrufa et al., 2010)). The upper tiers of the scale denote pairs working within larger teams, and then communication and cooperation between teams to work on common object. A good example of this is the WhatFutures project, which saw individuals take roles within small teams and communicating over WhatsApp (Lambton-Howard et al., 2019). Lambton-Howard et al. argue that by having each team member work not only with their group but also with members of other teams holding the same role, WhatFutures provided positive interdependence, or '*the sense that individual success depends on both group success and individual responsibility*'. Frohberg et al. argue that most of the projects they reviewed focused on learning scenarios with low communication and interaction, and that these projects missed out on potential for deeper learning and reflection.

Subject & Object

Frohberg et al. argue that a vast majority of the mobile learning projects they analysed were engaging with novices with little-to-no prior knowledge as the subject (learner). The authors

suggest that while novice learners are often easier for researchers to acquire and work with, novices are not usually expected to be able to perform higher forms of learning such as applying knowledge and reflection. As a result, they note a lack of research regarding systems where the object targets more experienced subjects.

3.2.2. Engaging Infrastructures of Place with Mobile Learning

The review by Frohberg et al. highlights that while m-learning projects frequently excel at teaching many 'traditional' curriculum subjects which often focus on physical environmental properties (such as biology, history and geography), few existing m-learning technologies capitalise on the embedded social value of their settings, thus potentially missing out on a wealth of civic learning resources (Frohberg et al., 2009). Additionally, while some previous research has explored how technologies can enhance and develop meaningful relationships with space and place (Giaccardi et al., 2008; Lentini and Decortis, 2010) or support existing classroom activities (Mann et al., 2016), little work has explored how technologies and design processes can utilise relational infrastructure for civic m-learning in public places. As noted by Frohberg et al, it appears that few mobile learning research projects have considered and exploited the multiple layers that comprise space and place: looking beyond their physical properties and engaging the learner with the socio-cultural, economic and political practices within civic space. It stands to reason that technologies designed for civic learning would likely benefit from the application of situated learning in authentic social and physical contexts. Leat's 'community curriculum' could be one possible way to achieve this: a place's stakeholders can also be valuable resources for civic mobile learning, acting as potential routes to introducing learners to new communities of practice and establishing community curricula (Leat, 2015).

The CrowdMemo project by Balestrini et al. engaged with the socio-cultural infrastructures of civic space in an educational context, using mobile technology as a platform for community storytelling (Balestrini et al., 2014). This study was particularly notable due to the community's strong uptake of project, and the levels of engagement displayed by stakeholders. The authors report that a key factor in the participants' engagement with the project was that they felt recognised and valued, both from inside and outside of their local community. One of the teachers noted that *'[the elderly people] who were interviewed by the students expressed enthusiasm and excitement, because they were being recognised for what they had done.'* The authors argue that the other main contributing factor was that the project provided value to all of the project's stakeholders, including the school students, teachers, the elders and even the researchers. Each of these groups had their own needs and agendas, which needed to

be fulfilled in some way in order to encourage meaningful participation and engagement. For example, some members of the community had a growing concern that failure to document and preserve the town's architectural heritage could threaten its future legacy and its identity going forward. Teachers were keen to provide new innovative and effective teaching techniques and content. Students valued being able to use technology for schoolwork which had normally been considered 'contraband', and learning new ways of utilising their devices. It appears that many of the elders simply wanted to be valued, and enjoyed being able to share their past experiences with younger generations who could keep their memories alive. Each of these motivations will have shaped those stakeholders' approaches and attitudes towards their involvement with the project. There is also a hint within the authors' report that the intersections of these motivations and experiences can provide excellent learning opportunities: for example, they note that *'the children were very keen to teach adults how to access the documentaries by scanning codes'*. In this instance, it wasn't only the elders passing knowledge down, but the children sharing their own with them in exchange.

HCI research has also explored how stakeholders can highlight their knowledge, values and identity through the creation of digital technologies outside of the context of mobile learning. For example, Fox and Le Dantec's 'Community Historians' project explored how communities' power dynamics could be examined through the participatory design of technology with disenfranchised communities '*not typically empowered to voice their opinions, let alone create their own systems or devices*' (Fox and Le Dantec, 2014). Through a series of workshops, the researchers explored how stakeholders can use the creation of technology to empower themselves and articulate community identity. They also argued that creating opportunities for non-experts to directly manipulate specialised materials (in this case, computer components and sensors) would allow stakeholders to gain a crash-course in understanding how those technologies work and could be used within their community. They argued that this 'democratisation' of technology creation created new opportunities for community stakeholders to create technologies according to their own needs and values: *'The potential of [accessible prototyping systems], and the aspirations of those who create them, turn on the ability to shift the dynamic away from the consumption of corporate-designed devices towards a more egalitarian structure of user-as-designer.'*

3.2.3. Seamless Mobile Learning

Sharples presents mobile learning as existing on a linear dimension from a fixed, curriculum-led context on one end, to one of informal learning in a mobile setting on the other (Sharples, 2013) (Figure 3.3). Whereas a formal learning setting might be in an environment such as a

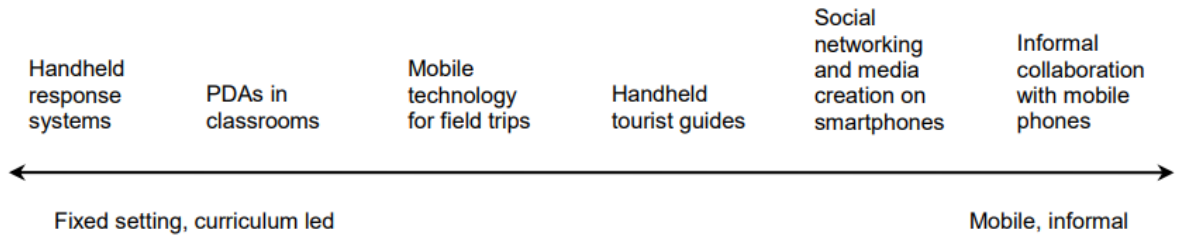

Figure 3.3 Sharples' example of types of mobile learning, plotted on a linear dimension from a formal and fixed learning context, to one that is mobile and informal (Sharples, 2013).

classroom, informal learning is less limited, and frequently in a mobile context. He notes that connecting these formal and informal learning contexts provides new research opportunities for mobile learning, working towards Kuh's proposed binding of different learning experiences into a single 'seamless learning' narrative, where the learning experiences are able to continue across multiple environments (and bridging formal/informal contexts) seamlessly (Kuh, 1996). Wong and Looi claim that seamless learning technologies 'empower and support' users in learning, whenever and wherever they are stimulated to do so (Wong and Looi, 2011). They identified ten desirable dimensions which characterise 'seamlessness' within mobile learning design: 1) encompassing formal and informal learning, 2) encompassing personalized and social learning, 3) learning across time and 4) locations, 5) ubiquitous access to knowledge, 6) encompassing physical and digital worlds, 7) using multiple types of devices, 8) switching between multiple learning tasks, 9) knowledge synthesis (e.g. combining learners' prior knowledge with new knowledge) and 10) encompassing multiple pedagogical or learning activity models. They note that more research could be done to investigate how mobile learning technologies could support four of these qualities (7 - 10) and use them to facilitate holistic seamless learning experiences.

In their investigation into the potential usage of mobile learning in rural Panama, Valderrama et al. found that 'multimedia rich' phones were welcomed by pupils and teachers for use in classroom activities, even without the installation of additional software applications (Valderrama Bahamondez et al., 2011). However, as mobile app stores have gotten more popular, most other studies have focused on custom, education-focused mobile software installed on otherwise off-the-shelf devices. These apps frequently either take a 'toolkit' approach (where the device and software are used for data collection or analysis, and contain little-to-no teaching material) or more guided approaches (where learners are scaffolded through more specific learning material).

For example, the Sense-it mobile application takes takes the toolkit approach, foregoing any scaffolded structure and acting as a free-form supporting tool (Sharples et al., 2017). It allows

users to conduct citizen science (research conducted by amateur scientists, usually through public participation of data collection) investigations through accessing detailed sensor information from their phone's hardware, without having any overarching activity scaffolding within the application itself. While alone it acts as an unstructured toolkit, Sense-it can be combined with the nQuire-it web platform to support users in contributing to others' created investigations or even designing and completing their own. However, the nature of Sense-it's citizen science focus means that the user interactions are limited to data collection activities, resulting in the mobile technology offering little creativity unless integrated into a larger project.

Mobilogue supports the authoring of location-based mobile learning activities, which linearly guide learners between locations using GPS and ask quiz questions at each one (Giemza et al., 2013). As with nQuire-it, Mobilogue's website component allowed students greater control through creating their own quizzes for their peers. The authors noted that this provoked a 'learning by teaching effect', and that the students were particularly engaged by seeing their created quizzes in action on mobile devices. This supports Heslop et al., who argue that higher level thinking and reflection can be promoted in students through them creating 'Digital Mysteries' for each other (Heslop et al., 2017). Once finished, Mobilogue users can clear their progress, allowing devices to be shared amongst multiple students in a class. However, as learners' responses in Mobilogue aren't uploaded for later review on other devices, opportunities for seamless learning through follow-up activities in other contexts are limited. This creative element was also only available on the website, with the mobile application's delivery of passive content offering learners little control when examined using the mobile learning task model (Taylor et al., 2006).

Wild Knowledge expands on the toolkit and authoring concepts, supporting varied learner activities made up of modular components (WildKnowledge, 2015). These include photography, audio recording, location logging and interactions often found on standard worksheets such as multiple-choice questions. Through the platform's website, users can combine these interactions into activities for others to complete. Learners can also upload their responses for later viewing on the website, where it is displayed in a comma separated (CSV) table format. This format would likely be too complicated for younger children, suggesting that Wild Knowledge was not designed as a seamless learning tool with this age group in mind. Other than being referenced in literature (e.g. (Traxler, 2013)), I am not aware of any research that investigates the use of Wild Knowledge in educational contexts. Furthermore, the platform's subscription model appears to focus on schools and businesses with a top-down delivery of content, rather than supporting individuals and communities in sharing information with a low financial barrier to entry (and engaging with social contexts for civic learning).

An example of a mobile learning technology designed for seamless learning is the MyArtSpace project, which created a seamless learning experience between a school trip to a museum and follow-up classroom activities, through the combination of a website and mobile application (Vavoula et al., 2009). Using the application, students 'collected' digital content linked to physical items in the museum in response to an inquiry. Learners could also upload their own images, text and audio recordings during the visit. On return to the classroom, students could review their collected content and use it to answer their given question. The technology successfully bridged the museum and classroom learning contexts, and increased levels of student engagement and reflection upon return to the classroom.

Following in the footsteps of MyArtSpace is Zydeco, another platform designed to support seamless mobile learning (Cahill et al., 2010; Kuhn et al., 2011). Zydeco is a learning platform comprised of a mobile application and a website, designed to help link classrooms with museum contexts by supporting greater integration of activities between the two. The authors argue that the authentic learning materials and interactive exhibits frequently present in museums make them ideal contexts for student-driven inquiry, but that this can often clash with the structured teaching style found in formal classroom learning. Zydeco aims to assist with this by supporting structured (but not overly limited) activities during museum trips, which the authors argue supports students in making '*cognitively-fruitful inquiry*' and conceptual connections to previous classroom activities. By using the website in the classroom environment, students and teachers are able to define goals and questions related to particular scientific investigations. This information is then able to be transferred to the mobile app, allowing students to respond to the created prompts in situ on school trips by taking, tagging and annotating photos. While paper-based worksheets requiring excessive writing can interfere with students' experiencing the museum, the authors argue that interactions such as taking photographs and writing short tags are less intrusive and would detract less from the learning experience. After the trip has completed, the students can then access these responses in the classroom to seamlessly continue their investigations. Through seamless learning, the authors argue that the application was able to utilize the affordances of both the classroom (structured, guided, formal, teacher-led) and the museum (exploratory, inquiry-based, more informal and student-led), by mediating the latter through a layer of scaffolding to assist the learners going to and from the former.

While offering seamless learning experiences across multiple contexts, these projects are somewhat limited in their scope for what the learner can use them for when in authentic learning environments. For example, MyArtSpace has only a limited ability for rich, reflective data capture: users can only create 15 second audio recordings, meaning that learners are limited to simply cataloguing information, rather than reflecting upon it in situ. In this

way, the recordings functioned as an audio equivalent of the photo tags and descriptions possible in Zydeco. These tags are again too limited for rich reflection, for which additional engagement upon return to the classroom would be required. Additionally, the applications' exclusive focus on indoor environments such as museums and galleries limits the scope of their activities, as it precludes elements such as location-based interactions. The MyArtSpace project was also reported to suffer from usability issues resulting from the app's reliance on typing and the website's interface. These elements would likely be somewhat mirrored with Zydeco, as it also relies on students inputting text with mobile devices. Rogers et al. argue that students may find it harder to switch between tasks which require higher degrees of cognitive workload, such as substantive amounts of reading, writing or data entry (Rogers et al., 2010). It isn't hard to imagine that these types of tasks could similarly distract learners from experiencing the learning environment. With these issues in mind, there seems to still be an under-explored potential for seamless mobile learning platforms which allow the creation of semi-structured learning activities which promote reflection in authentic learning environments.

3.3. Constructionism and Project-Based Learning

Blumenfeld et al. lament that small, easily assessed tasks which focus on low-level facts and skills (i.e. tasks commonly found on worksheets) have become the focus of many classrooms (Blumenfeld et al., 1991). They argue that these tasks afford students '*few opportunities to represent knowledge in a variety of ways, pose and solve real problems, or use their knowledge to create artefacts (shareable and critiquable externalizations of students' cognitive work)*'. Arguably this can be at least partly attributed to pressures and limitations put upon teachers and schools, as they work within structures which expect them to conform to quantifiable testing methods—propagating the aforementioned worksheet-style tasks and 'teaching to the test'. Admitting as much, the head of the UK's Office for Standards in Education (Ofsted) has noted that '*[Ofsted] have created a situation where second-guessing the test can trump the pursuit of real, deep knowledge and understanding*' (Ofsted and Spielman, 2018).

The learning theory of constructionism, introduced by Seymour Papert in the mid-1980s, stands in contrast to these worksheet-style tasks: Papert argues that constructing, sharing and reflecting upon physical or virtual 'public entities' (which could range from physical artefacts such as models of buildings, to virtual programming code or even conceptual theories of the universe) can be a powerful way for learners to build 'knowledge structures'—collections of knowledge, concepts and facts interrelated through various semantic relationships (Papert and Harel, 1991). Papert argues that the process of learning is the building of these knowl-

edge structures, a process which—while it occurs irrespective of the circumstances of the learning—happens '*especially felicitously in a context where the learner is consciously engaged in constructing a public entity*'.

In their overview of constructionism, Noss and Hoyles argue that constructionist working environments offer a medium in which learners can '*explore and learn from feedback, much as one can master a foreign language by living in the appropriate country*' (Noss and Hoyles, 2017). Noss and Hoyles also claim that they afford learners to take ownership of a construction-based approach, potentially leading to greater engagement, confidence and empowerment. Finally, they posit that through exploration and construction of public entities, learners can encounter 'powerful ideas': '*concepts and strategies that confront and build upon intuitive knowledge*'. For this reason, Noss and Hoyles argue that constructionist tools need to be expressive enough to facilitate these ideas emerging through the learner's construction of public entities.

Blumenfeld et al. argue that a preferable alternative to typical classroom activities is project-based learning (PBL), which they describe as an approach to teaching and learning which focuses on engaging students through the investigation of problems in a manner which supports learner autonomy over the course of an extended project (Blumenfeld et al., 1991). As an instructional pedagogy, PBL presents learners with a given 'problem' or task, requiring them to investigate and work on a given subject over a longer period of time. These problems are non-trivial and often framed as 'authentic', in that they are somewhat applicable to the real world. Frequently, students' projects will result in the creation of an artefact in response to the given problem (such as videos, reports, artworks, websites or performances (Holubova, 2008)), in effect making PBL a method of applying constructionism in response to real-world problems and supporting the inclusion of prior knowledge, domain research and greater levels of student autonomy. It's worth noting that several other configurations of pedagogy adjacent to PBL have been developed over time (e.g. problem-based learning), however they mostly conform to the same essential elements: a challenging problem or question; sustained inquiry; an element of authenticity; a degree of student control; reflection; critique and revision; and a final public product (Larmer and Mergendoller, 2019). Previous research has argued that these projects can serve to build bridges between classroom activities and real-life experiences (Blumenfeld et al., 1991), enhance applied and conceptual knowledge around a subject (Boaler, 1999), and that greater levels of autonomy and challenge can result in higher levels of student engagement (Wurdinger et al., 2007).

While some studies have found that project-based instruction is not necessarily more demanding in terms of teaching time and resources (Al-Balushi and Al-Aamri, 2014), Blumenfeld

et al. posit that by its nature PBL requires student engagement over extended periods of time (Blumenfeld et al., 1991). Krajcik et al. argue that constructing knowledge in meaningful and situated activities can take students more time, leading to teachers being hesitant to put it into practice when faced with strict and competing curriculum goals (Krajcik and Blumenfeld, 2006). The non-profit organisation Innovation Unit note '*[PBL] can be a powerful learning strategy if it is part of a whole school change process, and [schools] are ready and able to make the necessary time and staff available*' (Innovation Unit, 2016), suggesting that putting PBL into practice requires substantial changes in how teachers approach classroom structures, activities and tasks. This is easier said than done, as governmental pressures and restrictions frequently placed upon UK teachers often limit the amount of time they can dedicate to particular topics and experiential learning methodologies which don't target given examinations (particularly in later school years, which place greater emphasis on quantifiable assessment) (Ofsted and Spielman, 2018).

3.3.1. Mobile Learning and PBL

Project-based learning is recognised as a fertile ground for technology-enhanced learning. Bell argues that as long as it doesn't become the learning focus, technology can benefit all aspects of PBL (including research and data collection, knowledge sharing and artefact creation), and that tapping into students' existing computer fluency can boost engagement (Bell, 2010). ChanLin describes how students used digital technologies within PBL for researching on the web, taking photographs, participating in online communities and creating web pages as final artefacts (ChanLin, 2008). Heslop et al. found that the creation and sharing of interactive digital artefacts supported metacognitive skills, such as writing for an audience (Heslop et al., 2017). Sarangapani et al. explored how students could create interactive digital content as public entities to be shared with peers in other cultures, and argued that creating and sharing artefacts encouraged students to more deeply engage with the content (Sarangapani et al., 2018). Projects such as Science Everywhere demonstrate that sharing students' artefacts as public entities on social platforms can foster an element of ownership and appreciation of community resources (Ahn et al., 2018). However, these studies are of limited use for fulfilling all of the essential elements of project-based learning with mobile technologies, as they are either lab-based (Heslop et al., 2017) or do not use mobile technologies for the creation of interactive content (ChanLin, 2008; Sarangapani et al., 2018).

Chan et al. note that the use of mobile technologies in PBL has been under-researched, but in their study noted that students used mobile devices for multiple stages of the PBL process, including researching on the Internet, making notes, sharing materials and making

use of educational applications to help understand abstract concepts (Chan et al., 2015). Computing Science courses have also been adapted to PBL models, with students creating mobile technologies as their final public entities (Massey et al., 2006; Rahman, 2018). Massey et al. argue that this pedagogical approach aims to reframe the students as developers and decision makers of mobile applications, rather than simply end-users (Massey et al., 2006). Sarangapani et al. held studies in which students used mobile devices to create video recordings for cross-cultural PBL, noting that the schools claimed the resulting videos were accessible and engaging learning resources (Sarangapani et al., 2016). Students have also used Zydeco to use their research to prepare materials for use on school trips (Kuhn et al., 2011). These studies suggest that an m-learning technology can be configured to support the PBL process, be used to construct the project's final public entity, or even be the final public entity itself. With this in mind, we wanted to explore how m-learning technologies could be effectively utilised within PBL processes in schools, particularly in the process of students producing interactive public entities for other students as learning resources.

3.4. Summary

This chapter gave an overview of some of the previous research that has been undertaken regarding mobile learning technologies, as well as some of the theories which have influenced them. An important factor which benefits mobile learning technologies is that they can be situated in authentic learning contexts, both physical and social. Lave and Wenger's Situated Learning Theory highlights the importance of learner participation in activities, contexts and cultures which are 'authentic' to the subject being learned (Lave et al., 1991). There has been a push for outdoor learning in schools as a result (Fiennes et al., 2015).

Lave also places an emphasis upon learners entering 'communities of practice', moving from the community's periphery to its centre as they gain expertise over time (Lave, 1991). Previous Digital Civics projects have engaged with communities as sources of expertise (e.g. (Dodds et al., 2017; Rainey et al., 2019)). However, interactions with these communities can exist as more than a simple extraction of knowledge, as they are place stakeholders with their own motivations and agendas. Leat argues for the introduction of 'community curricula', where schools develop learning materials alongside community partners to make better use of community resources, highlight stakeholder voices and provide new opportunities for students to enter communities of practice.

Sharples and Taylor's task model for mobile learning emphasizes the learning environment, the balance of learner control vs guiding scaffolding, and the communication between

learners (Sharples et al., 2007). Frohberg used this framework to perform a review of early mobile learning literature (Frohberg et al., 2009), finding that many m-learning projects exist independently of the learner's physical and/or social context, or only offered passive learning experiences. He also suggested that mobile learning activities need to strike a balance of providing some guidance whilst giving students a degree of creative control over their work.

'Seamless' mobile learning technologies connect multiple learning contexts, such as formal classrooms and more authentic and engaging environments such as museums or the outdoors. Projects such as Zydeco provide opportunities for creating and transitioning data across these contexts, while also offering learners degrees of scaffolding in more informal learning environments (Kuhn et al., 2011). However, while many of these projects encourage data collection and note-taking in these authentic learning environments, they don't seem to encourage or enable learner reflection in situ—this is done back in the classroom, upon review of collected data.

Finally, project-based learning (PBL) is an instructional pedagogy which engages learners by engaging them with a problem or task (Blumenfeld et al., 1991). Over an extended period of time, learners research the given topic, and construct a 'public entity' in response to it. PBL has been shown to build bridges between the formal classroom context and real-life experiences, and is particularly engaging thanks to students being given greater levels of autonomy. While the use of mobile technologies specifically within PBL is somewhat under-researched, there are clear opportunities for the use of even existing m-learning projects throughout the PBL process.

Chapter 4. A Design Space for Public Places as Infrastructure for Civic Mobile Learning

Using the work covered in Chapter 2, this chapter explores how technologies can play a role in creating spaces where infrastructures for civic learning can be nurtured. It covers investigations held into the potential for civic technologies to support bespoke learning activities at the intersection between civic and curriculum-based learning in public spaces—in this case, public parks. It also describes the insights provided by eight months of engagements with some of the parks' stakeholders: teachers, pupils, park rangers and volunteers. This chapter covers the following engagements:

Method	***# Engagements***	***Purpose***
Workshops	4	1 formative workshop with park stakeholders; 3 with teachers and park rangers to understand more specific requirements, issues and practices
Site Visits	5	Gain understanding of parks' resources, current usage, park rangers' issues and practices in context
Prototype Deployments	2	Investigate how students would respond to technology prototype
Follow-Up Teacher Interviews	2	Gain insight from teachers into students' behaviour, feedback on in-school application of technology

Through these engagements, I aimed to gain an understanding of the potential for mobile technologies to explore the different stakeholders' current issues and practices; explore how these can be used as resources for civic learning; and develop generalizable design requirements for future technologies for m-learning within civic space. Finally, this chapter introduces a model of the design space for civic m-learning, and draws implications for designing platforms that support outdoor civic learning activities aimed at enhancing and developing relationships to spaces which have value to their surrounding communities.

Much of the work covered by this chapter was peer-reviewed and published at Communities and Technologies 2017 (Richardson et al., 2017), with the paper being co-authored by Doctors

Clara Crivellaro, Ahmed Kharrufa, Kyle Montague and Professor Patrick Olivier. This chapter expands on that paper. All authors provided feedback and advice on the paper's writing and contribution, with Doctors Kharrufa and Crivellaro providing assistance during the school engagements and ranger workshops, and Doctor Crivellaro also advising on and corroborating the findings of the thematic analysis detailed in section 4.4.

4.1. Study Context

As discussed in Section 2.4, this project was situated within a larger socioeconomic and political context of hardship currently being experienced within the UK. Significant budget cuts resulting from policies of austerity had been imposed on local government, resulting in a severe re-allocation of funds. This study concentrates on a specific consequence of this: the reduction of funding for the maintenance of local parks. Since their popularisation in the Victorian era, public parks have been a staple of British culture, offering the working class respite from spreading urbanisation and the pollution of industry. Modern research has shown that simply having access to urban green space is essential for childhood development, as well as good mental and physical health (Fiennes et al., 2015). Today, access to green space is often limited, with 80% of the UK's population living in urban areas which take up only 6.8% of its land area (UN Environment World Conservation Monitoring Centre, 2014). This study took place in Newcastle upon Tyne, UK, where the Newcastle City Council's Parks Service manages 12 traditional Victorian Parks, 9 countryside parks, 15 neighbourhood parks and a multitude of other sites, including several denes, reclaimed industrial sites and recreation grounds. In total, the sites managed by the Parks Service amount to over 2 million square metres of space.

Because local authorities do not have a statutory duty to fund and maintain their open spaces, local parks have had their budgets slashed under austerity measures in order to minimise the impact on other areas, such as schools and healthcare. In 2014, the Heritage Lottery Fund found that 86% of UK park managers had seen cuts to their budgets since 2010, with some local authorities considering simply selling their parks to private investors (Heritage Lottery Fund, 2014). Between 2010 and 2019, Newcastle City Council has had to reduce its parks budget by over 90%. In practice, this means the loss of over 80% of the parks' full-time staff (despite park usage increasing), increasing their reliance on volunteers from local communities. It also means that councils are being forced to explore other ways in which parks can generate income. Many authorities have reluctantly introduced—or increased—entrance fees, and are charging schools to facilitating class trips. The combination of a loss of dedicated education staff within parks, the introduction of fees to compensate for park

rangers' time, and the schools themselves having to deal with funding issues has resulted in few schools utilising the parks as learning environments. As cost-cutting measures, even fewer take advantage of the rangers' expertise as educational resources.

The purpose of this study is not to place greater value upon local parks than the many other elements of society which have suffered from austerity measures. Instead, it serves as a case study exploring how issues which affect places as outwardly simple as parks can impact a large number of community stakeholders in many different ways, and how mobile technologies might use that as a platform for learning and sharing those stakeholders' values.

4.2. Engagements Held During the MRes Period

This section consists of work which was carried out as a part of my MRes studies, which this PhD is a direct continuation of. Because the findings generated from these studies proved formative for the rest of the project and led directly into the PhD, they warrant detailed coverage and discussion. As such, this section is presented as contextual background to the rest of the PhD project.

However, while some high-level quotes and analysis are presented here, much of the data resulting from these studies was actually analysed later during the PhD's early stages, alongside a second deployment of the developed prototype and some follow-up interviews with participants. As they were developed during the PhD, the insights gained from the studies detailed in this section are presented separately in Section 4.4. The studies particularly relevant to this analysis are covered in greater detail in this section.

4.2.1. Identifying the Research Domain: Parks2026

A larger Open Lab project had started in 2015, with the aim of researching the potential for digital technologies to mitigate the impact of austerity politics on Newcastle's parks services (Crivellaro et al., 2019). During my MRes studies, I joined the project's initial engagement process, dubbed 'Parks2026', in an effort to find a context to engage with for my PhD. This section will only cover the main and relevant insights from the Parks2026 study, as I am not reporting on this work as a part of my own research.

The Parks2026 process consisted of an exploratory workshop, which investigated the value of local parks as a general community resource and offered the various stakeholders opportunities for opening dialogue around the future of the parks. The workshop aimed to act as a

Figure 4.1 Participants engaging in the Parks2026 workshop board game.

scoping mechanism, investigating the current practices and attitudes towards technology held by park staff, volunteers and council representatives. The workshop was attended by 25 participants (mostly staff and volunteers, participants noted the absence of several invited council representatives). Discussion was aided through the introduction of a group board game, which asked its players to envisage their park ten years in the future (Figure 4.1). Participants played the game in groups of 4-5, with discussions being audio-recorded and decisions noted down by an elected group member.

The game utilised provocative 'scenario cards' to probe the players' thoughts on specific hypothetical near-future scenarios, based upon earlier discussions with the project's prior participants. These scenarios addressed issues such as the players' favourite aspects of their park, the democratisation of it as a resource and the introduction of technology in the organisation of volunteers. Amongst these topics were also several related to situated learning mobile applications. Participant groups were asked to discuss the scenarios, and agree on potential solutions or approaches in response to them.

The discussions highlighted that the participants cared deeply about the parks, and saw them as a resource integral to the surrounding community. However, one aspect which many of the park rangers and volunteers seemed particularly eager to emphasize was the role of the park as an educational resource. They saw school trips and other similar activities as an opportunity to not only increase the park's perceived value to the community through its use, but also to expose and encourage a new generation to become future 'wardens':

"Well it does give you the opportunity to engage on a more long-term basis with different groups—say a youth group to like the art, or schools or something like that. To develop some relationship." - Workshop Park Ranger 1

"Well the potential benefit is enormous, because it means that a group of people will hopefully become involved in the park in a continuing fashion." - Workshop Park Ranger 2

Participants were also keen to point out that the benefits of this relationship flowed both ways, and that schools had much to gain from the park as a physical resource and the expertise of the park rangers:

"Well, I suppose that's why you have to have the park staff working with teachers: the park staff know the park, and the teaching staff know what works as good education." - Workshop Park Volunteer 1

From these discussions, it became clear that the individuals involved with the parks—both employees and volunteers alike—saw a huge amount of value in them as educational resources, but were simultaneously frustrated that they were going underutilized by the surrounding schools. These findings inspired me to further research the intersection of community space, technology and education during my MRes studies. I decided to further investigate how the parks were being used by schools and the potential value of parks as learning resources.

4.2.2. Exploratory Field Studies

Several exploratory visits to five different parks were held to understand the learning resources that they offered, how they were being used by schools, the attitudes towards the parks by their local communities and the time and budgetary constraints that the park rangers had to deal with. These parks varied from some of the more deprived areas of Newcastle to some of the most affluent. Each park was visited at least once, with the more central (Parks 3 & 4) and well-supported (Park 1) ones being visited several times, due to the more frequent interview availability of rangers and volunteers. Field notes were recorded during and immediately after each visit, and photographs were taken of the sites' facilities and educational resources. Unstructured interviews were held with the rangers at each site, typically as we toured the grounds. These interviews were audio recorded and transcribed, and inductive coding was

performed on them, with the findings being further informed by the collected field notes and photographs (contributing to the discussion in section 4.4).

The rangers argued that there was a positive correlation between an area's prosperity and the amount of community support given to its local park. For example, Park 1 had roughly 20 volunteers perform maintenance work on a weekly basis, with several times that number volunteering in some less regular form from the fairly affluent surrounding area. In comparison, despite being larger, Park 2—based in one of Newcastle's more deprived areas—saw only five or so weekly volunteers. Secondary schools had also almost entirely stopped visiting Park 2, which was something that the rangers were keen to rectify. In comparison, Park 1 has been actively coordinating with local schools on several projects, including the design of a new pond space. The leading volunteer of Park 1 claimed that they hoped to get the children invested in the park from an early age, so that they could contribute towards its maintenance later in life or at least appreciate and respect the park as a community space.

While all of the visited park rangers confirming that schools' usage of the park had significantly decreased in recent years, some school trips were still occurring. A school trip to Park 2 was observed, where a large class of young children (N=36, age=5-6) were taken by the park ranger on a hunt for mini-beasts. The park ranger was the sole content deliverer for the session: despite multiple teachers being present (necessary for large groups), they deferred to the ranger's expertise on the given subject despite the ranger's professed lack of teaching experience. The children's discoveries, such as snails and worms, were photographed by the adults through the use of several iPads. The teachers claimed that the photos were to be put on display on return to the classroom, and the devices never left the adults' hands.

During a visit to Park 3, the park's ranger showed how it had also been struck severely by the budget cuts. The park boasts a sizeable and modern indoor facility dedicated to educational activities (featuring desks, chairs, projector and smartboard) and a large number of educational resources such as worksheets and pre-made activities. However, the reduced budget meant that there is no longer a dedicated educational officer in the park. Without an educational officer no new educational activities have been produced, and school trips have to be facilitated by the park ranger. Having not made them, the ranger was understandably largely unfamiliar with the learning resources and activities. Furthermore, the ranger also had to charge schools for their time, as they still had other responsibilities. The learning resources themselves were relatively simple, with the majority of them taking the form of paper worksheets (Figure 4.2). Most of the resources prominently featured images and simple text instructions with very few of them requiring the children to write significant amounts of

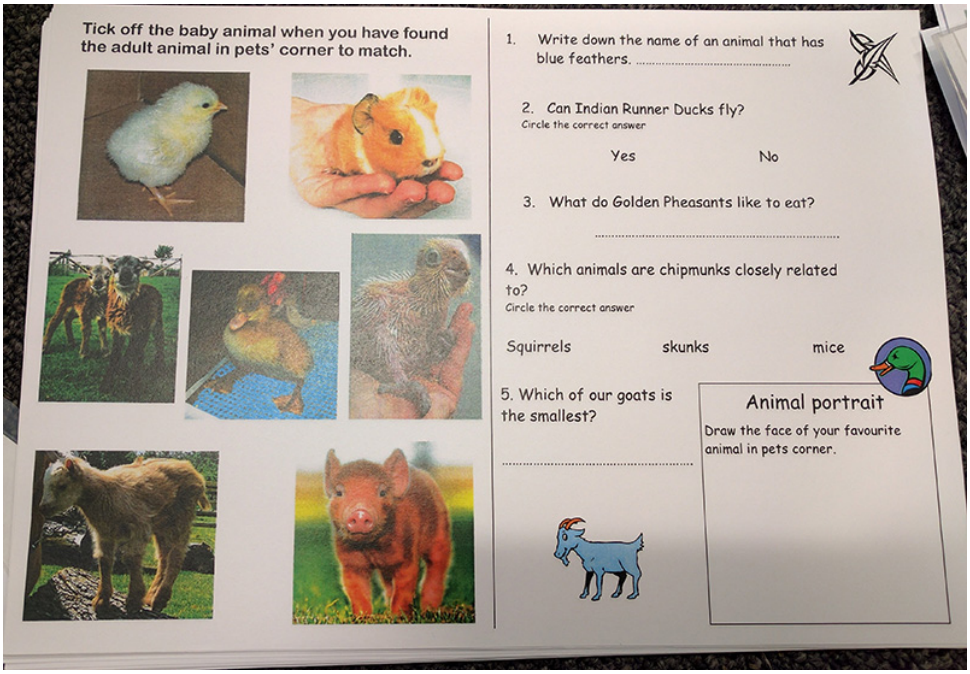

Figure 4.2 An example school worksheet, created by the Park 3 educational officer.

text. Nearly all of the worksheets relied on the children being physically present in the park in order to answer questions about the plants and animals found within it.

Park 3 had also already utilised technology for educational purposes in multiple ways. QR codes distributed around the park which linked to wildlife information websites when scanned (Figure 4.3). However, these QR codes lacked any context prior to being scanned, and the rangers claimed that few people interacted with them. The visitor centre featured both a tabletop display and a digital kiosk. The tabletop interface displayed a custom website, featuring a map of the park; an overview of the park's history, comparing historical photos with modern ones; historic points of interest; and an interactive quiz regarding features, plants and animals of the park. The kiosk boasted a touchscreen and speakers, and allowed for user generated content such as images and video of the park to be publicly displayed. However, the rangers noted that neither of these pieces of equipment were frequently used, and that the table top interface was prone to frequent crashing.

This series of site visits highlighted that the parks, as well as the rangers and volunteers who support them, were an educational resource going underutilised by both schools and local communities, particularly in areas experiencing socioeconomic deprivation. While there were learning resources available, they were often not being fully utilised due to financial and institutional restraints placed upon both the rangers and schools. While attempts had been made to use digital technologies as mediums for knowledge sharing without the requirement

Figure 4.3 A QR code found in Park 3, linking to a wildlife information website.

for the rangers' presence, they seemed to be going unused due to a lack of clarity, reliability, or contextual relevance.

4.2.3. Initial Application Concept

Having made these observations, I decided to explore how a mobile learning application which simplified the processes of creating, organising, sharing and consuming park learning materials could benefit the park rangers and schools. Based on these initial findings and an early exploration of some of the literature covered in Chapter 3, I identified several high-level, key design goals for a mobile learning application designed for use by the park rangers and volunteers, as well as local schools and communities. These goals were to: support authoring of content engaging with both space and place; support learning in space and place; encourage learner agency; and require minimal time investment from stakeholders.

Based on these initial design requirements, I designed a model by which existing learning activities could be adapted into a modular format, potentially suitable for later translation into a digital application. These modules were inspired by the existing worksheets used by the park rangers (e.g. Figure 4.2), which could be separated by activity topics and then broken down into smaller tasks which required a user interaction. For example, a worksheet could hold the activity topic of "Animals in Pets' Corner", and include tasks such as drawing and multiple choice answers. As the medium of mobile technology afforded more complex interactions than a simple pen and paper, I also noted several additional interactions could

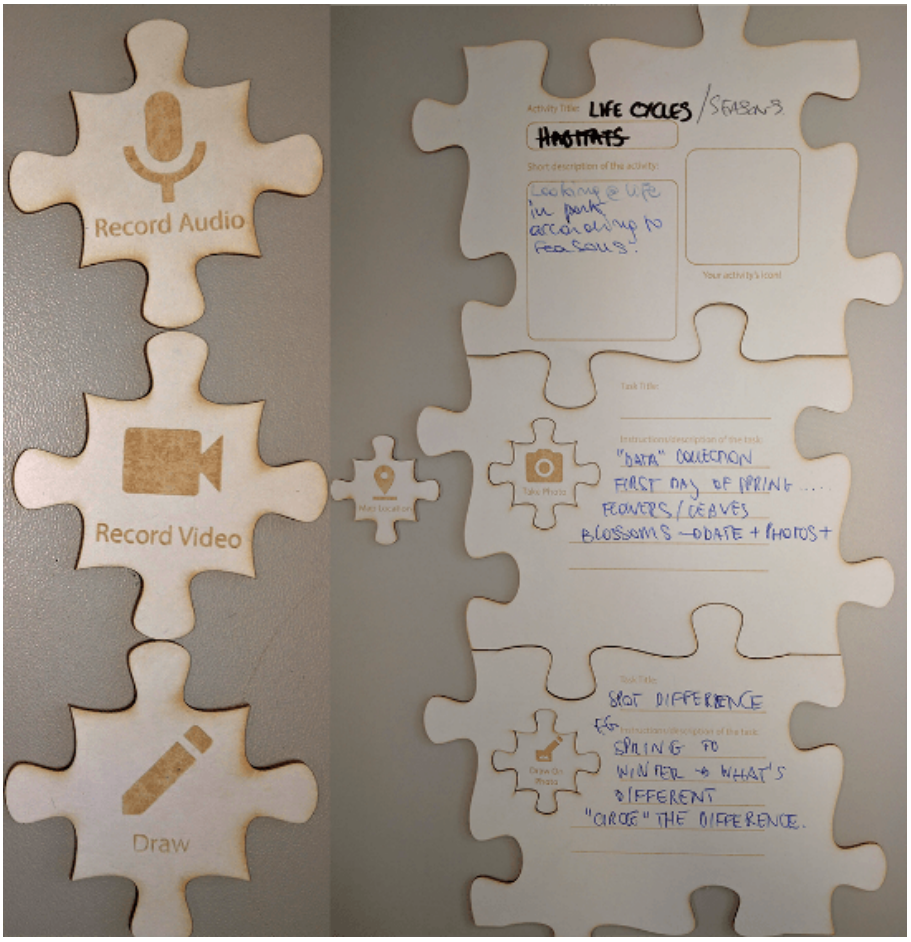

Figure 4.4 The paper prototype jigsaw workshop activity, used with rangers and teachers to ideate mobile learning activities and prompt discussion around the initial application concept.

make use of current mobile technology, such as photography, audio recording and GPS map-marking.

In order to make the modular relationship between these tasks and the larger activities more clear, I conceived a paper prototype in the form of physical laser-cut jigsaw (Figure 4.4). Each jigsaw consisted of a root piece which could be filled in to detail the activity's subject, and multiple other pieces which represented the tasks that the learner would be asked to complete. The pieces were designed to be as configurable as possible, allowing for simple, non-linear or even cyclic activity design. The user interactions were represented by their own, smaller pieces. Some of these were left blank, to allow for participants to suggest ideas for the types of interactions the application could have. Others consisted of interactions which utilised the mobile technology (e.g. recording video), or ones which conformed to the existing learning materials (e.g. drawing a picture). The jigsaw activity was designed to be highly tactile, in an attempt to encourage curiosity and experimentation different activity

configurations. The jigsaw was also highly visual, which I hoped would allow participants to work in small groups and communicate ideas easily.

4.2.4. Park Staff & Teacher Paper Prototype Workshop

I held a small 90 minute workshop to explore some park stakeholders' (two park rangers, a teacher and a retired teacher who volunteered at the park) thoughts on the initial design concept and, if supported, co-design its potential features and some learning activities. The participants' discussions were audio recorded, transcribed and later coded through an inductive thematic analysis (contributing to the discussion in section 4.4).

After briefly introducing the participants to the design requirements and initial overall concept, I asked the participants to work in pairs to paper prototype mobile learning activities using the jigsaw activity. Beyond the given scope of 'a mobile learning application for use in parks, using ranger-created content', the nature of the technology was kept deliberately vague, in order to encourage participant interpretation and them airing unanticipated ideas.

The participants identified a number of potential themes for mobile learning material to be used in parks, including habitats, life cycles, maths, growing food, history, physics, citizenship and healthy living. Overall, they were positive about the idea of creating and sharing digitised mobile learning materials. However, several concerns were voiced which a final system design would need to take into account. The teachers noted that for such a system to be used by schools, it would likely have to be able to show proof of each child's learning and progression over time. There was also a concern that if these activities were to be created by anyone in the surrounding community, they would have to be screened and vetted for appropriateness before being made visible to children.

Unfortunately, the participants also struggled to understand the jigsaw format, and didn't meaningfully engage with the paper prototype. The jigsaw appeared too abstract for the participants to clearly understand without first seeing a working version of the app. Despite my encouragement, the teachers were also verbally reluctant to write on the pieces, as they saw them as reusable learning resources which shouldn't be written on. While the participants had been receptive to the idea of a mobile learning application for park educational activities, it was clear that the jigsaw was too abstract of a prototype to gain much useful feedback. I posited that this would be the same—if not worse—with child participants, and that to gain an understanding of children's attitudes towards the parks and technology, something more appealing and less abstract would be necessary to engage them.

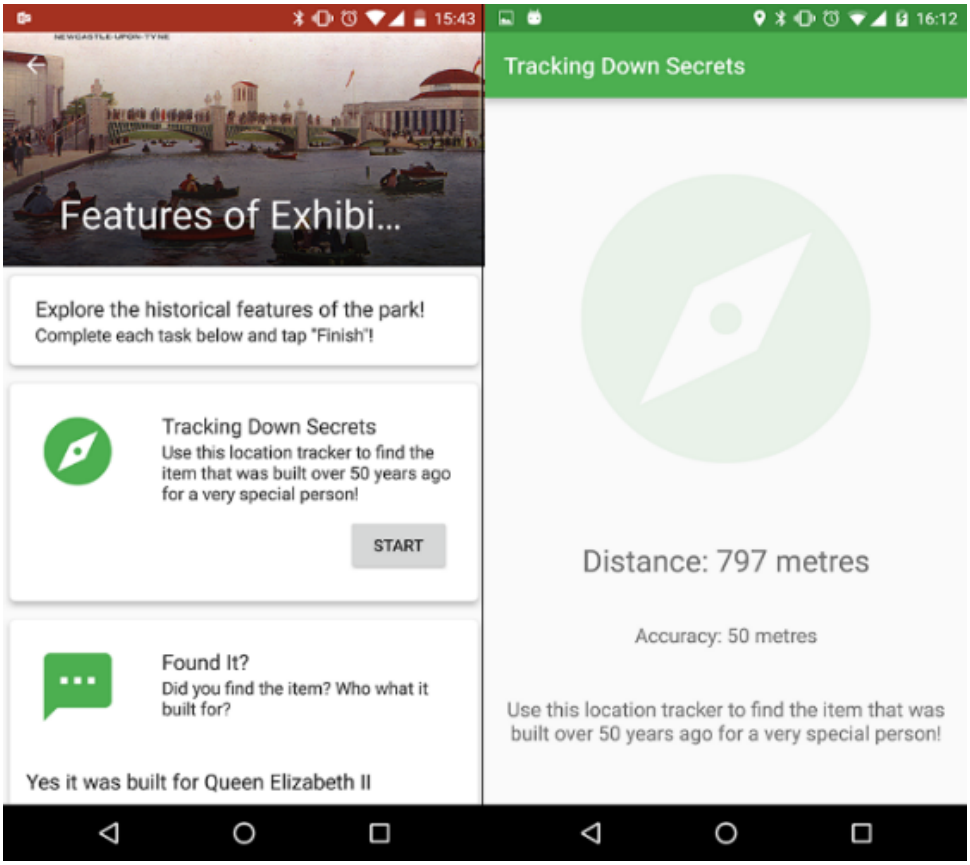

Figure 4.5 The prototype ParkLearn application.

4.2.5. Application Prototype

Based off of the structure of the jigsaw activity and the initial design goals, I developed ParkLearn: a mobile learning application prototype for use with children on school trips and adults in further workshops. I hoped that engaging with this functional prototype would be more fun and intuitive than the previous engagements, leading to further insights.

ParkLearn acted as a technology probe, offering a number of modular interactions which could be configured together into outdoor learning activities (Figure 4.5: left). The application was developed for Android mobile devices using Xamarin, a mobile development platform which utilises cross-platform implementations of the .NET framework to allow for a largely shared codebase between Android and iOS (Xamarin, 2016). More detail about the application's development and implementation can be found in Chapter 5.

This prototype version featured a number of learner interaction types, including taking a photo ('*Take a Photo*'), matching an existing photo using a translucent image overlay on the camera ('*Photo Match*'), recording video ('*Record Video*'), recording audio ('*Record Audio*'), drawing digital pictures ('*Draw a Picture*'), drawing on top of taken photos ('*Draw on Photo*'),

marking a location on a Google Maps view ('*Map Marking*'), tracking down a location by the device's distance from a geo-coordinate ('*Location Hunt*'—Figure 4.5: right), choosing between pre-written answers on radio buttons ('*Multiple Choice*') and simple text entry in an empty textbox ('*Text Entry*'). Each of these interactions were chosen either because they put an element of creative control into the hands of the learner, took advantage of the devices' hardware capabilities to support explorations and reflections of space and place or—as in the case of Multiple Choice and Text Entry—emulated features of the learning materials currently in use.

Unlike projects such as Ambient Wood (Rogers et al., 2004) and Explore! (Costabile et al., 2008) which required additional equipment or the production of expensive digital assets, ParkLearn activities could be self-contained within the device and very quick to create due to the app's modular nature. In the task model for mobile learning (Sharples, 2013), these features were chosen to support the design of activities which are intrinsically linked to the context of the park, and use a wide variety of tools which allow for content construction a large degree of learner control.

Unlike later versions of the application featured in later chapters, the prototype did not allow for the creation of new activities within the app itself. Nor could they be loaded from from a remote server, as this had not yet been developed. Instead, activities had to be manually written in the JSON (JavaScript Object Notation) data format and hard-coded into the app. I created some sample hard-coded activities prior to the following engagements in order to demonstrate the application's functionality. These activities were based on the existing worksheets and activities witnessed during the previous site visits.

4.2.6. Prototype Engagements

With the functional prototype in a usable state, I held further engagements with various park stakeholders to further understand the potential roles for mobile learning technologies within civic spaces. These engagements consisted of workshops with adults (one with teachers, another with park rangers) and a deployment of the prototype with children attending a local summer school near a large park. The workshops were made up of short activities and semi-structured group discussions focusing on the participants' relationships with parks as places, their use of the parks as learning environments, their general experiences with outdoor learning, their use of educational technologies and their thoughts on this design concept.

The engagements were all audio recorded, transcribed and coded through an inductive thematic analysis. This section will give an overview of these individual engagements, with section 4.4 detailing the themes which resulted from the final qualitative analysis.

Teacher Workshop

To gain some first impressions and feedback from potential real-world users of the technology, I organised a three hour workshop with substitute teachers of various disciplines (N=5; three working in secondary schools, one in primary schools, one covered all ages from from nursery to secondary school; one taught business studies, one design and technology, one science, two general primary school teachers). As it took place during the UK's summer school holiday period, these teachers were hired for the afternoon through a supply teacher agency.

Following a short live demo of the application, the participants seemed to understand the concept and saw potential in the idea. This ran in contrast to the previous workshop, suggesting that I was correct in thinking the jigsaw prototype may have been too abstract as an introduction to the application concept. The remainder of the workshop consisted of a semi-structured group discussion concerning the teachers' previous experiences with outdoor learning in schools, as well as their ideas for what activities and interactions could be created for this type of application.

The majority of the teachers had substantial experience with teaching outside the classroom, and all reported that they would like to more regularly incorporate outdoor learning into their teaching. They also noted that the national curriculum had affected the flexibility of teachers of older students (particularly in secondary schools), meaning that fewer trips tended to take place.

They claimed that there was a multitude of obstacles that stood in the way of a teacher being able to hold an outdoor lesson. The immediate concerns were related to cost (with transport being the biggest expense) and short lesson times:

> *"In some schools, lessons are getting shorter, and if you're trying to get pupils out—even if you are doing technology and its a double lesson—it's very hard to get pupils where you want to get them. Transport costs... because I mean the parks are not always very far away, but you can't always walk. If you want to do a walk, you have to add more members of staff. It was okay getting my GCSE pupils out, but getting my lower year sevens out..." - Workshop Teacher 1*

One of the more interesting issues was related to the negative social perception of learning outside of the classroom: the teachers noted than many parents see it as "slacking off". The physics teacher explained how they had received a complaint from a parent who had glimpsed their class teaching on the school field, despite the lesson being very successful:

> *"One [parent] complained, and said they weren't in the learning environment. It was just this weird perception. The parents looked at it and saw 'Look at those students relaxing, that's not going to be a learning environment'. But they'd never had as much focus as when they were just relaxed, lying in the grass." - Workshop Teacher 2*

The physics teacher noted that in order to minimise these types of complaints, there are institutional pressures for teachers to collect evidence of learning from each session:

> *"You would have to collect evidence whilst you were there to show what you've been doing, because that's something that the bosses will be wanting." - Workshop Teacher 2*

The teachers were very positive about the students' digital literacy, noting that many of the children have grown up using digital technologies and touch interfaces:

> *"I don't know about you but the ones I taught in technology, they could do it because they'd been brought up on it. You don't have to tell them anything—they don't think about it, they just do it." - Workshop Teacher 1*

In response to the capabilities of the application, the teachers created a large number of topics and activities well suited to mobile learning technology in parks, including subjects such as biology, art, design, textiles, geography and physics. Some of the imagined user interactions included map reading and writing, path-finding, video recording and analysis, triangulation, measuring parallax through photography and recording environmental audio.

Park Ranger Workshop

With a greater understanding of the teachers' perspective, we organised another 90 minute workshop with the park rangers (N=3), held in the rangers' facilities in Park 4. Collectively,

the rangers had several decades of experience hosting educational events and activities in the parks with schools and local communities. As with the teachers' workshop, this session consisted of me giving a short demonstration of the prototype application, before holding an audio-recorded, semi-structured group discussion which aimed to gain some further insight into the specifics of educational practice within the parks, and how such a technology could be of benefit.

The subjects that the rangers reported to have taught in the park were extremely diverse. While the most common topics usually were related to biology, they had also taught children subjects such as the social history of the surrounding area, geographic topics such as erosion and river tributaries and the impact of humans of the environment. Park 4 also boasted a very large collection of existing educational worksheets, but they were rarely used as the poor organisational structure meant that if a particular activity was required, it would have been difficult to find in a timely fashion.

The rangers all agreed that the introduction of the National Curriculum had a large impact on how the park was used for education—while previously many of the educational activities had taken a holistic, free-form approach to the general appreciation and protection of nature, teachers now had to ask for very specific topics to be covered in order to fit into their curriculum plan:

> *"Before [the National Curriculum] we used to do quite a lot things like earth education, which was not specifically about a particular subject. That really disappeared out the window once the National Curriculum came in, because all the teachers had specific targets that they had to meet. They have to cover all of these points in the curriculum. It's quite specific." - Workshop Ranger 2*

The national curriculum also affected the demographics of the park's educational activities: due to the more focused structure and requirements of the later stages of education, the number of visits by Key Stage 3 (11-14 years old) groups dwindled. According to the rangers, the current most frequently visiting age group is Key Stage 1 (5-7 years), followed by Key Stage 2 (7-11). This was in line with the teachers' experiences. However, once the funding to the parks started being cut, they had to start charging schools for trips in an attempt to compensate. Unsurprisingly, the rangers claimed that as soon as the charges to schools were introduced the number of visits from them "dropped off".

The discussions also revealed that the rangers were largely unhappy with how the disruptions caused by the lack of funding had affected their day-to-day jobs. The lack of resources

Figure 4.6 Groups of children finding and photographing habitats in a local park, using the ParkLearn prototype application.

available to them meant that they had to shoulder more physical work related to their park's upkeep and had less time to focus on elements such as education and long-term developments for the parks. They explained that it was not the same job they had wanted to do, expressing a desire to become more involved in education again:

> *"I would say we're more park keepers than rangers now. I definitely think we've been 'dumbed down', put it that way. I personally would like to see us going back to doing some more of this [education] stuff." - Workshop Ranger 1*

The rangers were keen to introduce a technology which supported educational trips and activities in parks. However, a prevalent concern was the implementation of an unnecessary technology which simply interfered with children's interaction with nature. The rangers could see the use in a system which acted as a guide or resource for teachers wanting to incorporate outdoor learning into their curriculum planning. The rangers also liked the idea of an application which gave guides on caring for the park environment during group visits and advised on specific areas and hazards to avoid.

Figure 4.7 A child documents his discoveries to the app during the second prototype deployment, using the 'Take a Video' task and a cardboard microphone.

4.3. Prototype Deployments

Two deployments were held with two groups of children in two different parks, in order to investigate how the prototype would be received by students in outdoor learning contexts.

The first deployment took place during the MRes period, with its data further analysed during the PhD. The participating students (N=23, aged 4-12) were recruited through an out of school club, due to the study taking place during the school summer holiday period. For the study, the students were split into small groups of 2-3 (grouped by age bracket), and each group was supplied with a smartphone or tablet. The groups were given different activities according to their age: for younger children (age < 6) (Figure 4.6, left), the app asked students to take photos of plants and wildlife, using the *Photo Match* interaction. The older children's (Figure 4.6, right) activity used more complicated interactions, asking them to *Location Hunt* items of historical significance in the park, record a short nature documentary style video and draw their vision of the park's future on top of one of their own photographs (which some groups didn't complete due to time limitations). These activities were inspired by the worksheets which had been previously created and used by the park rangers.

The second deployment took place several months later, during this PhD. This deployment was much more free-form in its activity design, taking place during a school group's (N=55, aged 4-5, accessed through a colleague's existing relationship with the schoolteacher) weekly visit to their local park. To fit into the teacher's experiential, child-led approach for the visit, the application was presented as an optional tool which children could engage with if they wished. Tablet devices running the application were offered to five students (one device per child) who weren't engaging in other activities, such as tree climbing or playing in mud. The app was loaded with free-form activities which were designed to fit the child-led learning approach, encouraging the children to catalogue their findings during their usual self-guided explorations of the allocated park area in pictures and video. To further appeal to the young children, I produced several laser-cut 'microphones' for the children to use as props while role-playing as documentarians (Figure 4.7). Of the 5 children who were approached, 3 completed the app's activities, while 2 disengaged when they realised that it wasn't a video-game.

Following these deployments, follow-up interviews were held with the class teachers, with the aim of getting feedback on the prototype and ideas for future developments. These audio recorded, semi-structured interviews were around 30 minutes in length, and largely focused on the teachers' thoughts on the deployment and the technology.

4.4. Engagement Insights

As previously discussed, the data resulting from these studies was analysed during the PhD period. The various forms of data collected (audio transcriptions of the workshops, interviews and deployments; photographs taken during the deployments and workshops; and the children's responses to the ParkLearn activities) were collated on a per-engagement basis, before undergoing a process of inductive coding. While this process initially resulted in several dozen codes, these were gradually combined into a smaller number of overarching themes, which were in turn distilled further after triangulation through two discussions with Dr. Clara Crivellaro. Together, we agreed on three main themes which are presented here for discussion: 'self-guided learning', 'citizenship through place-making', and 'stakeholder tensions'.

4.4.1. Self-Guided Civic Learning

Discussions with the park rangers and teachers during the workshops and interviews revealed that, in their view, outdoor learning played a critical role in children's development as citizens. They argued that the exposure of children to new experiences, environments and community members is an essential element which helps children to discover their passions and equip them to make decisions about their future. The concept of children exploring their environments to discover and nurture new interests through independent learning was raised repeatedly during our workshop discussions. As one teacher noted:

> *"They pick [these professions] because they are exposed to a wider variety of natural things, they have a choice to make. [...] We shouldn't just tie our pupils into traditional classroom activities. [...] Expose children so that when they grow, they can become specialists." - Workshop Teacher 3*

Our workshop participants strongly believed that this process was reliant on children's independence—if children were to find new interests and passions to take into later life, there would have to be significant degree of autonomy and freedom of learning. One ranger noted that this was one of the reasons they had configured the educational sessions they used to deliver to lean heavily towards independent learning, with the children having a significant amount of control over their activities:

> *"It's about listening to the child and following what they want to do, as opposed to being subscribed." - Workshop Ranger 1*

While this element of self-determination was recognised as important, one teacher also noted that the children would still often need scaffolding, or at least a teacher's presence to act as a facilitator and an enabler for the children's explorative curiosity:

> *"It is much more about allowing the children to make their choices. [...] You don't do anything apart from facilitating and listening to them." - Workshop Teacher 2*

Our participant teachers claimed that the children were discovering their passions over time through outdoor exploration, play and experimentation. One teacher noted that eventually, these various interests would organically emerge into themes of personal passions which could be identified (and then supported) by their teachers:

"It's about dealing with children's own interests and passions. [...] Maybe by February there's some children who have a theme going." - Workshop Teacher 3

The initial design ideas (as with many existing mobile learning applications) were not particularly well suited to this process. Rather than allow for self-guided exploration and fluidity, the technology's initial activity design in the first deployment had been prescriptive: resulting in the children exploring my ideas, rather than their own. One of the more visible examples of this was an activity which tasked young children to Photo Match images of types of leaves in the park. The children took this more literally than expected, and tried to line the shot up perfectly with the leaf overlay. The result was the children cared more about taking the photograph than learning about the surrounding nature. The second deployment's more open structure allowed for the application to take an embedded role in the session's explorative activities—the technology, along with the park itself, became one of a selection of optional resources. For the participants who chose to utilise the technology, the creative potential of the application encouraged them to further engage in personal explorations of the park environment and document their discoveries (Figure 4.7).

4.4.2. Citizenship Through Place-making

The teachers noted that as the children advanced through the early years of school, the focus of school activities changed from the sensory and experiential to the practical and applied. Project-based learning activities are introduced, allowing multiple school subjects to be taught around the periphery of a single class venture. In the school, an example of this was the development of the school's garden and pond area. However, the rangers saw these projects as being opportunities for learning topics which extend beyond the current school curriculum. They saw opportunities for civic learning, giving children an appreciation for the local parks and the work that goes into maintaining them. They wanted children to be able to explore the environment at their own pace, taking time to understand and appreciate it. Beyond this base appreciation, they hoped to instil a sense of ownership, belonging and responsibility. They wanted these learning activities to be place-making. As one ranger noted:

"[The children are] Being involved in developing [the park], studying it. So that they feel like it's their park—not just some open space to throw cans in. [...] They have ownership of it, the whole thing, and then maybe they'll appreciate it and look after it." - Workshop Ranger 2

For the rangers, working alongside the schools allowed them to teach children the civic value of parks. To them and the surrounding communities, the parks are more than just their physical components of open spaces, woodland and shrubbery. They have a true social value, something which needs to be treasured, nurtured and—crucially—communicated and passed-down. The rangers were very aware that the parks would soon be likely to be even more reliant on community support and volunteering. A possible route to future sustainability lies in instilling this sense of civic responsibility and duty of care. The activities designed to nurture this ownership tended to be creative in nature, allowing the children to feel like they had personally contributed to the spaces. Examples of the activities the rangers organised with schools included children creating artistic roundels to surround a new pond and designing and building a nature area. The aim was to use this newly produced area to build long lasting relationships between students and the space over the course of their academic careers: using it for experiential activities, creation and, eventually, study. The rangers noted this link between creation and ownership:

> *"They're actually involved in making the park: they planted that willow, and they planted some bulbs. So, they've been involved while quite young in creating this wildlife area and taking ownership of it. Hopefully, once it's established, we can involve older kids in actually studying it." - Workshop Ranger 2*

The rangers hoped that these studies would again be mutually beneficial for both the schools and parks: as well as allowing the students opportunities for situated outdoor learning, the parks could benefit from the collected data. They noted that they hoped students' findings could be fed into organisations such as the Wildlife Trust and local citizen science projects, further increasing the perceived value of the parks to their surrounding communities.

There was a broad range of attitudes amongst our workshop participants concerning technology's role in parks' place-making. Some were critical, viewing many technologies as distractions from the learner's environment: the rangers and teachers alike were concerned that if a child is focusing on the technology in their hands rather than what's surrounding them, how can they form a meaningful relationship with that space? However, there was also optimism about the use of technology as a powerful tool within this space. Some saw it as a way of furthering students' engagement with and appreciation of the natural environment, with one teacher noting:

> *"I think [recording] audio would be really interesting to just listen to what the park sounds like, [...] because I don't think we listen to nature enough. [...] Just appreciating it." - Workshop Teacher 1*

Other ideas included using technology as a tool through which the rich social history of the parks could be uncovered and contextualised. Through the app's photo-matching activity, the rangers suggested that children could compare the park of today to that of a hundred years ago. These differences could be used to contextualise the changing attitudes towards the parks' usage and upkeep, as well as foster an appreciation for the efforts of the parks' current volunteers (a resource which wasn't previously required, due to the large number of paid staff).

4.4.3. Stakeholder Tensions

Despite Ofsted urging schools to perform more outdoor learning activities, many teachers struggle to take their lessons outside—especially into parks. Through the workshops and interviews, we found that many aspects of the economic and institutional infrastructures surrounding the parks and schools restricted the amount of outdoor learning that could be supported, making for a difficult design space.

Recurrent and obvious was the topic of funding, for both the schools and parks alike. Most parks have had their budgets cut to the extent that they now have fewer staff: where there may have once been dedicated educational officers, rangers are having to cover in their stead in addition to their previous duties. Thus, schools are now charged for educational activities to (partially) compensate for rangers' time, which is always in high demand. Schools suffering from budget cuts also compound this, resulting in many choosing to stop utilising the rangers as resources for expert knowledge or even ceasing trips to parks altogether.

The nature of our society has also resulted in an unequal access to nature in many people's lives. Indeed, many of the original Victorian parks were originally created for the health benefits of factory workers. For urban areas living with child poverty, parks are a valuable resource—both for access to nature and new social opportunities for civic learning. The theme of natural environments being social equalisers was present in our discussions: parks allow for children to exist, play and learn on a level playing field when extraneous factors are stripped away. The teacher of the class which partook in the second deployment noted in the interview afterwards:

> *"In the classroom, he's lost. He doesn't have a TV at home, his parents are very highly educated and he finds it hard to mix in with the other children. But in the woods, it's a level playing field, because there's no TV, there's no toys that match anything that they might have seen on a film or anything like that. I suppose, for him, it's his day that he's on a par with everybody else." - Deployment 2 Teacher*

Through the discussions with workshop teachers, additional tensions were revealed. Of particular note were the teachers claiming that there existed a prejudice and stigma against learning outside of the classroom. Despite the physics teacher claiming their class to have 'never had as much focus as when they were just relaxed, lying in the grass', the teacher had to to defend the practice against outside scepticism. Amongst other institutional requirements, this necessitates that teachers create schemes of work and collect evidence of learning. This target and evidence-based methodology clearly conflicts with the experiential, holistic approach used for children's self-development. These highly structured, prescriptive formats result in little room for exploration and the unexpected. Furthermore, the targets set by the UK's National Curriculum mean that schools must teach very specific topics and meet specific targets, limiting teachers' creative control and freedom in their activity design. One ranger (who happened to be a retired teacher) claimed that toeing the line of the national curriculum has resulted in many teachers losing the ability to teach topics in a manner tailored to students' interests:

> *"You couldn't do that now, because of the curriculum. It's so structured. Many of the teachers have gone through that system now, and it's hard for them to go back and think creatively about how do it—it's been knocked out of them." - Workshop Ranger 2*

The increasingly lofty and specific learning targets for slightly older children are also affecting what is being taught in the earlier years of their education. Many schools are aiming to get children up to target earlier in their school careers—forfeiting the holistic experiences for the rote-style learning found in the later stages of school. Resistance to these top-down influences appears to be on a per-school basis. The teacher from the second deployment explained why their school still delivers the holistic sessions:

> *"The curriculum is so heavy now with the grammar: our Year 6s need to know what 'fronted adverbials' are. [...] That's so high now it's just filtering down. The pressure on what the children need to be able to do is just increasing. And it's our way of saying 'we value children's imaginations and children being children', so we keep doing this." - Deployment 2 Teacher*

However, the current institutional climate realistically only allows for these entirely free-form activities to take place during the earliest years of a child's school life. For schools to be able to sustainably hold outdoor learning activities for older children within the existing school infrastructure, they must conform to the expectations of targets and evidence set upon them.

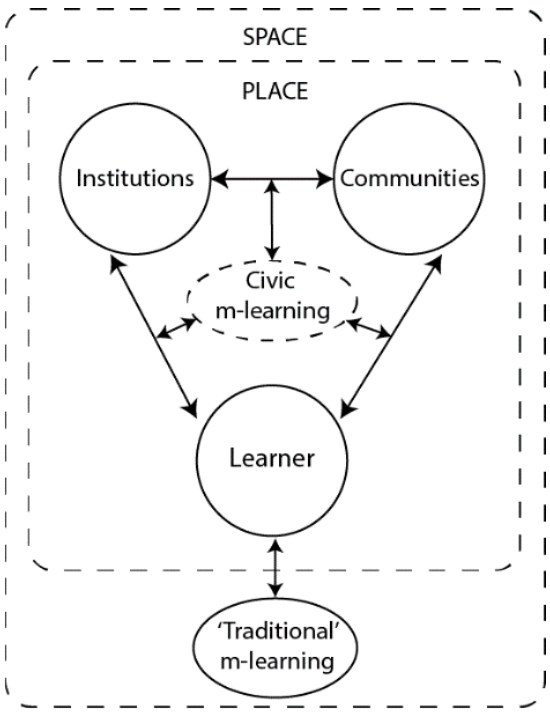

Figure 4.8 The social design space for mobile learning technologies, where relationship infrastructures connect stakeholders in space and place. 'Traditional' m-learning refers to mobile learning technologies which don't meaningfully engage with these infrastructures, and are either independent of the learner's context or concentrate solely on the physical aspects of the environment.

4.5. The Social Design Space for Mobile Learning Technologies

These findings highlight that civic mobile learning in parks—and more broadly in civic spaces—is a rich but challenging design context. It's clear that for a technology to be successful within these community spaces, it must be designed in consideration of those places' pre-existing socio-economic infrastructures. This requires an awareness of the motivations of each place's stakeholders and the relationships that exist between them. In our park context, a design must allow for teachers to work within a set of pre-determined parameters, with the resulting deliverables supplying evidence of learning. Similarly, rangers' time and resources are precious due to their plethora of commitments and lack of funding, so the activity design and creation processes must be quick and easy to distribute. While teachers may aim to teach to a strict, pre-written curriculum, rangers might prefer to strengthen learners' relationships with the park and instil a sense of ownership. The local government want the parks to remain valuable community resources, but don't have the funding to allow the previous amount of spending to be sustainable. I argue that technology can offer new opportunities to surface these complexities for use as civic learning resources.

Based on these findings, I present a generalizable model of the social design space (Figure 4.8). In the Task Model for Mobile Learning (Taylor et al., 2006), this new design space can be positioned within the 'Context' element of a mobile learning activity. Frohberg et al. further delineate this into more specific sub-categories of learning context—I propose that this new model exists as a bridge, navigating the divide between their physical and social learning contexts.

The model illustrates how in the context of mobile learning, space and place (be that a park, school, or any other place with which people have developed relationships) comprises of multiple actors: learners, communities, institutions and technologies. 'Communities' are made up of individuals who encounter the place in question—for parks, that would include teachers, rangers, volunteers, members of the public, or other learners—united by a common interest, goal or issue. For example, communities around local parks might include volunteer groups, local residents and school groups. 'Institutions' are those that impose requirements and/or restrictions on the other groups: for example, Ofsted or the city council. Each of these actors interact with the others through layers of infrastructure: for example, actors may exist within a community of practice, and the city council may introduce financial tensions with the park rangers through policy. These infrastructures all contribute to comprising the park as a place.

However, most current mobile learning technologies only interact with the learners in physical space, oblivious of the socio-cultural, political and economic relationships that constitute place. If a technology is to be well suited for civic learning within this space, it needs to be produced with the interactions between stakeholders in mind. Civic mobile learning involves more than just the learner and the space in which they reside: it also involves other stakeholders' relationships—both with the space, and each other.

4.6. Suggestions for Designing Technologies for Civic Learning

Based on these findings and the identified design space, this section presents some suggestions for designing technologies to interact with these socio-economic relationships to support civic learning, and how we can design mobile learning technologies to extend the learning focus to include the social context.

4.6.1. Create Opportunities for Giving Form to Stakeholder Values

As suggested by Dourish and Bell, by considering the infrastructures that constitute a place, we can more easily understand the values that its surrounding communities associate with it (Dourish and Bell, 2007). Analysis of a place's different actors and stakeholders offers researchers not only a greater appreciation of the multiple practices and values of it, but also opportunities to design technologies that accommodate those stakeholders and bring them in relation to one another.

An awareness of the variety and import of stakeholder viewpoints, practices and values becomes even more necessary when the communication of these values is the technology's defined purpose. In this project, the rangers' and teachers' agendas were very different, despite being stakeholders in the same space. Understanding the contexts and spatial infrastructures (socio-cultural, institutional, financial) where these values are enacted is key to designing appropriate technologies for civic learning in these spaces. We found that despite being major users of civic spaces such as parks (and therefore are stakeholders like any other actors), children's values, practices and views regarding parks are often overlooked. Designing for civic mobile learning might entail the development of platforms that allows multiple stakeholders—including children—to express their values and practices and put them in dialogue with one another, encouraging political agency from an early age and developing their spatial citizenship (Gryl and Jekel, 2012).

This potential can extend beyond the scope of individual places and communities operating within them. Indeed, thanks to their potential for seamless learning across multiple physical and social contexts (Wong and Looi, 2011), mobile learning technologies could operate as platforms for the sharing of values, practices and resources between and across different places and communities. Bringing the practices and values in different communities and places into dialogue with one another can offer productive civic learning opportunities (Wegerif, 2007). Fischer has also noted the need for collaboration amongst communities, and claims that spatial, temporal, conceptual and technological barriers can be turned into creative opportunities (Fischer, 2004). Gryl and Jekel claim that the core competencies required for spatial citizenship are expression (constructing and communicating meanings of geographic information), communication (sharing those ideas and meanings with others) and negotiation (engaging in democratic discussion in an effort to find compatible meanings with others) (Gryl and Jekel, 2012). Thus, mobile learning applications within this design space should look to support users in creating and sharing material which implicitly or explicitly communicates their stakeholder values. Further studies in this thesis will expand on the ParkLearn prototype to explore this, using ParkLearn as an example of how the processes

of authoring, sharing and responding to digital, place-based learning materials can be used to surface and express stakeholder values.

4.6.2. Support Place-Making

Through analysis of the workshops and interviews, it became clear that the process of independent learning and self-discovery was intrinsically linked to place-making. Children can explore and learn about their environment at will, allowing for unique and meaningful experiences to occur. The rangers were confident that these regular and meaningful interactions over time eventually lead to the formation of relationship between the learner and their environment. Yi-Fu Tuan claims that place-making is made possible through individuals 'pausing' in space to make it place (Tuan, 1978). However, I argue that rather than this passive act of pausing, place-making can be more effectively promoted through *doing*—individuals entering an active engagement and creation process within a place and engaging with its various socio-economic infrastructures. Relph posits that we build relationships with space through our experiences with it, and that these experiences are often mediated through technology (Relph, 1976). To this end, I argue that mobile learning technologies looking to promote and develop learners' relationships with place should promote independent learning, curiosity and creativity within authentic learning environments to encourage active engagement with place.

Students' engagements with space appear to transition from passive (consumer) to active participation (producer) as they mature: the teachers noted that as the children progressed in age, they transitioned from activities which were experiential and explorative, to creative ones in which they were actively affecting their environment and effecting change. The rangers saw this as a means of place-making: by actively having a hand in the creation of areas of the park, children would be taking ownership and forming relationships with it. The rangers' values were embedded into these activities, in the hope of them being passed onto a new generation. I argue that technologies for civic learning should support this transition into active participation within society. To assist in this process, mobile learning technologies might act as both creative tools and new socio-technological infrastructure: empowering users to create new unique works, and share and absorb the knowledge of others in a place's community through an ongoing dialogue and exchange between the learners and other stakeholders. In this way, mobile learning technologies could act as mediums for 'cross-media interactions' which support heritage as a personal and living practice (Giaccardi et al., 2008). As an example of how this could be implemented in a mobile learning application, communities could create their own activities in ParkLearn to form their

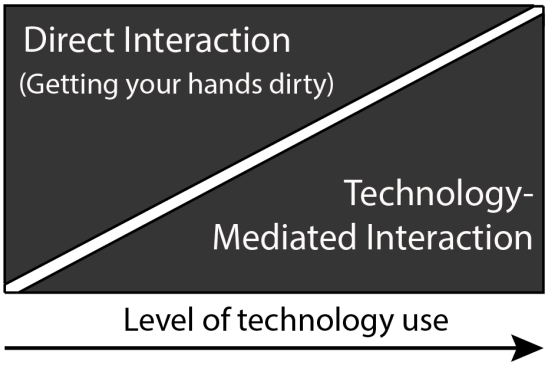

Figure 4.9 Balance the amount of direct and technology-mediated interactions to find the 'sweet-spot' for civic learning.

own informal curricula: sharing values, knowledge and promoting place-making through situated learning. This thesis will later explore this concept in more detail, with students building their knowledge of—and relationships to—local places through the creation of their own mobile learning content.

4.6.3. Balance the Use of Technology

During these engagements, stakeholders' perceptions of the role technology might play in parks weren't always positive. Some of the participants saw the inclusion of technology as something that could distract from the learning experience and place-making. This is a valid criticism which could be levelled at many mobile learning projects: for example, (Shih et al., 2010) shows a photograph of a class visiting a temple, engrossed in their mobile devices rather than the environment around them. As civic learning is tied to practices of place-making, when designing for civic mobile learning we must be mindful not to place technology at the 'experiential centre': a technology designed for civic education and place-making should not presume itself to be the learning objective, and instead take a background supporting role. We must acknowledge that there are situations where the very inclusion of technology may not be appropriate. For example, the inclusion of a technology could completely negate explorative outdoor learning's equalising effects if not all children are familiar with it. As HCI designers, we must recognise and appreciate that the value of a physical or social space could be jeopardised by heavy-handed outside involvement—sometimes the lack of technology in a space could be why it is precious to begin with.

However, technologies can offer new learning opportunities which might not otherwise be possible or feasible. For example, mobile learning can give stakeholders platforms to communicate their own values and motives concerning place; expose the values of others to

learners across time and space; augment physical reality with digital information; and allow for dynamic and creative learning activities thanks to the available networking and hardware features. Thus, a careful balance must be maintained between the potential benefits of civic m-learning's inclusion and the risk of its overuse. A 'sweet spot' (specific to the learner and the learning context) can be found in the space between completely direct, hands-on activities without any technology use and a fully technology-mediated approach. As the focus on one increases, the other decreases, and their respective benefits follow (Figure 4.9).

4.7. Summary

This chapter gave an overview of this PhD project's origins. Motivated by the visible impact of austerity politics on local parks—particularly the educational services which they had previously provided—I started investigating the resources that these spaces offered, their use by local schools, the relationships held with them by their surrounding communities, the constraints and tensions felt by the stakeholders which regularly engaged with them as places, and how mobile learning technologies could be used to surface these elements as learning material. These initial studies resulted in a greater understanding of the design space for engaging with a place's social infrastructures as learning resources, and how mobile technologies can be more suitably designed for civic learning.

Contextually, these studies engaged with the results of the austerity politics that originally inspired the Digital Civics agenda. It was clear that the funding cuts had drastically impacted the way that park rangers managed the spaces, with them becoming much more reliant on community volunteerism. While this seemed to be working in a few (typically affluent) areas, the rangers were afraid that it wasn't sustainable for the majority in the long-run. A reduction of full-time staff meant that educational activities were given significantly less support, meaning that existing educational resources and the expertise of the rangers themselves were going underutilised. In response, I proposed a design for the mobile application ParkLearn. This app could be used by schools and communities to make use of the rangers' knowledge, without requiring their immediate presence.

This application was prototyped, and used as a technology probe during engagements with stakeholders (teachers, students, park rangers and volunteers) to which the participants were receptive. These engagements were useful in promoting discussion around the importance of students' self-guidance, the promotion of active citizenship through building relationships with community spaces, and the various tensions held by the stakeholders in their relationships to the parks as places. These insights inspired the creation of a design

space which highlights the different stakeholders' current issues and practices. With minor adaptation, this model should be adaptable for civic mobile learning in settings other than parks. I also offered some implications for designing platforms that support outdoor civic learning activities and place-making, highlighting the importance of creating opportunities for stakeholders to give form to and share their values with others; encourage place-making by supporting independent learning, curiosity and creativity; and the need for an awareness of the over-use of technology to be a disruptive and negative factor when learning in authentic environments.

Chapter 5. Designing and Implementing the OurPlace Platform

Following the engagements covered in Chapter 4, I decided to iterate upon the Park:Learn prototype application to produce a platform which could be utilised in formal and informal learning contexts and aim to follow the implications for design derived from the findings of the previous study. This chapter describes the design goals for the technology, why those goals were chosen, a detailed overview of the application itself and how it evolved over the course of the remainder of the project.

Much of the work covered by this chapter was peer-reviewed and published at MobileHCI 2018 (Richardson et al., 2018), with the paper being co-authored by Doctors Pradthana Jarusriboonchai, Kyle Montague and Ahmed Kharrufa. This chapter specifically expands on the design section of that paper, for which Doctors Montague and Kharrufa provided support and feedback for its structure and the framing of its contribution.

5.1. Technology Design Goals

Based on the findings of previous works, existing literature, and the design engagements covered in Chapter 4, I produced several design goals (DGs). This section describes each design goal and the rationale behind choosing them.

DG1: Utilize local places and communities as learning resources

This first goal is that the final technology should support greater utilisation of local places (e.g. parks, buildings, towns, rooms, etc) and the communities which surround, inhabit and have built relationships with them as learning resources. This is in response not only to existing literature highlighting the potential value of spaces/places (Frohberg et al., 2009; Gryl and Jekel, 2012) and local communities of practice (Dodds et al., 2017; Leat, 2015) as learning resources, but also the previously discussed Park:Learn studies: during which it was found that places' stakeholders can offer not only a diverse knowledge base, but also a large

variety of motivations, aspirations and tensions related to place. In Chapter 4, I suggested that mobile learning technologies could make use of these social infrastructures by giving stakeholders a new platform for sharing their values by designing and distributing learning materials in authentic contexts. This technology should not only support learners in situating their learning activities within authentic physical environments, but ideally also introduce them to new communities of practice, into which they may enter and develop new expertise through further community interactions (Lave et al., 1991).

DG2: Support seamless outdoor and classroom use

As noted by Sharples, mobile learning does not necessarily always take place in one context, or even one fixed level of formality (Sharples, 2013). He presents mobile learning as taking place on a linear spectrum: from formal, classroom and curriculum-based learning activities, to ones that are informal, creative and *mobile* (Figure 3.3). However, while these contexts are different, they can still be connected—Kuh argues that learning experiences across contexts can be bound into a 'seamless learning' narrative (Kuh, 1996). In order to support this seamless use across contexts, our design should encompass as many of Wong and Looi's 'desirable dimensions' of seamless learning as possible (encompassing formal and informal learning; encompassing personalized and social learning; learning across time and locations; ubiquitous access to knowledge; encompassing physical and digital worlds; using multiple types of devices; switching between multiple learning tasks; knowledge synthesis (e.g. combining learners' prior knowledge with new knowledge); and encompassing multiple pedagogical or learning activity models) (Wong and Looi, 2011). While multiple examples of seamless mobile learning applications which adhere to some (or all) of these dimensions already exist (e.g. Zydeco supports the use of multiple types of devices across multiple locations, utilising both digital and physical learning resources (Kuhn et al., 2011)), these technologies have not been designed to support the other design goals for this project. Whilst encompassing Wong and Looi's elements, this technology should also be self-contained and support the creation of bespoke learning materials both in and away from authentic social and physical learning contexts.

DG3: Support a variety of pedagogical approaches and stakeholder requirements

The final 'desirable dimension' listed by Wong and Looi is that seamless mobile learning technologies should encompass multiple pedagogical models, as a diversity of learning experiences requires the deployment of different learning models (Wong and Looi, 2011). For

example, the learning theory of constructionism and project-based learning pedagogies (as covered in section 3.3) have different requirements to more traditional classroom teaching methods. Sessions within these pedagogies will often have different goals, with the intended outcomes also changing according to the stakeholders' agenda (e.g. as discussed Chapter 4, teachers may want to be able to provide evidence of students' learning, while park rangers and volunteers may want to promote place-making in an attempt to nurture stewardship and volunteerism). As such, this technology needs to be flexible enough to support different goals, learning processes and intended outcomes, ideally without relying heavily on additional tools.

DG4: Support a wide range of user ages and technical expertise

While the teachers in this project's early workshops argued that children are frequently technologically adept, care still needs to be taken to support age and ability groups who may struggle with reading or typing large quantities of text (as shown to be an issue in MyArtSpace (Vavoula et al., 2009) and deliberately avoided in Zydeco (Kuhn et al., 2011)). Furthermore, engaging with a large variety of place stakeholders means that older age groups—who may not be as technologically literate—may wish to use the technology. This technology design should therefore strive to minimise (or provide alternatives to) large amounts of typing, and, as suggested by Land, attempt to support a range of learner ages and reading abilities through the use of simple, varied but semantically consistent visual interfaces (Land et al., 2015).

DG5: Support student-led learning and reflection in authentic learning contexts

Prior observations in the initial engagements (as well elements found in prior work, such as in Mobilogue (Giemza et al., 2013)) demonstrated that giving students greater control and opportunities for creativity can act as a motivating factor. As such, this design should aim to utilise interaction methods on mobile devices which support student creativity and control in authentic learning environments. That said, while not all mobile learning projects make use of the learner's context as a learning environment or resource (Frohberg et al., 2009), even fewer promote learner reflection within the authentic learning environment. For example, MyArtSpace (Vavoula et al., 2009) and Sense-It (Sharples et al., 2017) encourage learners to use the technology to collect data or take brief notes and observations, rather than engage in in-depth reflection in-situ. This is certainly useful, and should have a place in the final design. However, we wanted our design to also support immediate reflection from the learner, even before they return to the classroom. This level of immediacy should also apply to activity

creation and data collection, in an attempt to minimise the learner being distracted from authentic engagement with the learning context.

DG6: Support mobile learning in resource-limited schools

As discussed in sections 2.4 and 4.1, the UK as a whole is enduring an extended period of austerity and local authorities have had to cut funding wherever possible. As a result, many schools have become resource-limited and may struggle to justify spending money on having more smart mobile devices for classroom use, despite them becoming more affordable and fashionable within education. While the final software design will require the use of a smartphone or tablet, it must take steps to minimise the financial strain placed upon schools in its use. The design should: require minimal teacher time to set up and use, as well as access and download student work; support the sharing of devices between multiple students, either through group work or the ability to save and clear progress to allow another student to start activities afresh (as seen in Mobilogue (Giemza et al., 2013)); and support the offline caching of data, allowing teachers to pre-load content in the classroom prior to trips, or queuing student work for later upload (avoiding expensive 4G mobile data contracts).

5.2. An Overview of ParkLearn and OurPlace

ParkLearn, the prototype application discussed in Chapter 4, was further developed to meet these design goals. While the early version was created as a simple proof of concept and acted as a technology probe (with content which was hard-coded, rather than user-generated), later versions of ParkLearn featured far greater functionality, before finally being re-branded to 'OurPlace' in response to the findings of the workshop detailed in section 6.2.4. This section will detail the application: its features, its implementation, and how it evolved over time into the later OurPlace app. For the sake of clarity, 'OurPlace' will be used as the application's name for the rest of this chapter. Significant differences in features or implementations between ParkLearn and the final version of OurPlace will be noted explicitly.

The OurPlace platform consists of three main components (Figure 5.1): a mobile application (for Android/iOS), a back-end cloud server, and a user-facing website. Core to the OurPlace platform's user experience are the acts of creating and responding to interactive digital learning activities ('Activities'). While the Activities in the prototype version of ParkLearn were hard-coded into the application, later versions allowed users to create their own Activities inside of the app, without requiring external devices or software. The main screen of the

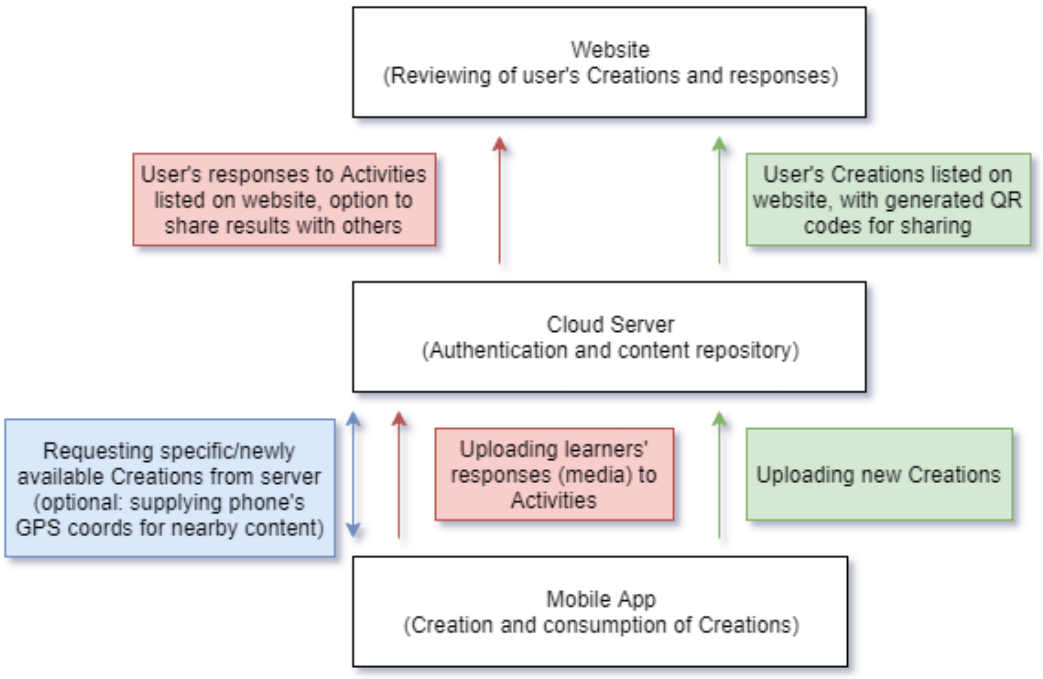

Figure 5.1 An overview of the OurPlace platform, which consists of a mobile application (for Android/iOS), a back-end cloud server, and a user-facing website.

OurPlace app reflects this focus, consisting of two main sections separated by tabs: 'Highlights', which shows content created by all users which has been marked as 'public', and 'My Creations', which lists the Creations (Activities and/or Collections, defined below) created by the current user. The media (i.e. images, video, text, audio) created by learners in response to Activities can be uploaded to the cloud, and accessed by the learner on the accompanying OurPlace website. This website also lets users view their created OurPlace Activities and generates QR codes to make sharing them easier.

As schoolchildren are one of the main target audiences for OurPlace, the platform was designed with user privacy in mind. Learners' responses to Activities (which could potentially include sensitive data, such as images of children) are not shared with the Activity's creator without the learner's expressed consent. Similarly, Activities can be marked as 'private' rather than 'public', meaning that they cannot be found by others on the platform without the author first distributing the Activity's generated share or QR codes.

This section details each of the core components of the OurPlace platform and how they are used: how Activities are experienced by learners, how users can create their own content, and how that content can be shared with others.

5.2.1. The Anatomy of an Activity

In terms of user interaction, OurPlace's Activities are very similar to the digital learning materials introduced in the prototype ParkLearn application, which were in turn based on the original jigsaw workshop activity (Figure 4.4). While the Activities in the prototype version were hard-coded into the application, later versions allowed users to create their own Activities, or complete other people's. They are delivered to the mobile app by the cloud server, allowing users to discover and open Activities in numerous ways, including: scanning QR codes, inputting share codes, and discovering nearby Creations through supplying the user's GPS coordinates. These methods of sharing Creations are covered in more detail in section 5.2.5.

Activities are typically based on a particular topic, location or subject (e.g. '*Exploring the Rose Garden*'). Each OurPlace Activity must feature a title and a short (up to 150 characters) description, which gives the learner some insight into what the Activity will be about (Figure 5.2). Additionally, Activity creators may choose to include an image to represent the Activity: this will appear on the application's feeds, and at the top of the main Activity screen. The application supports taking this image directly through the device's camera, or the use of pre-existing images from the user's photo gallery (allowing users to select images they prepared earlier, or downloaded from the Internet). By allowing both options, activity creators are able to either create their Activities within the relevant physical context (addresses DG5) or remotely, which may be easier if preparing for a future school trip (addresses DG6).

Each Activity must also feature at least one 'Task'. Tasks are small, modular pieces of content centring around one of a number of pre-defined user interactions (e.g. '*Take a Photo*'). A large number of variations ('Task Types') of Tasks are available, supporting a berth of different interactions (addresses DG3). Section 5.2.2 describes all of the different Task Types available in OurPlace (note that '*Scan the QR Code*' was introduced during the re-branding from ParkLearn to OurPlace after the workshop detailed in section 6.2.4). An Activity can have an unlimited number of Tasks, and the learner is able to complete them in any order.

Each of these interactions were chosen either because they put an element of creative control into the hands of the learner (*Take a Photo, Draw a Picture, Draw on Photo, Record Video, Record Audio*) (addresses DG5), took advantage of the devices' hardware capabilities across different contexts (*Listen to Audio, Map Marking, Location Hunt, Scan the QR Code*) (addresses DG2), emulated features of the learning materials already in use by teachers and park rangers (*Information, Multiple Choice, Text Entry*) (addresses DG3), or a combination of all of the above.

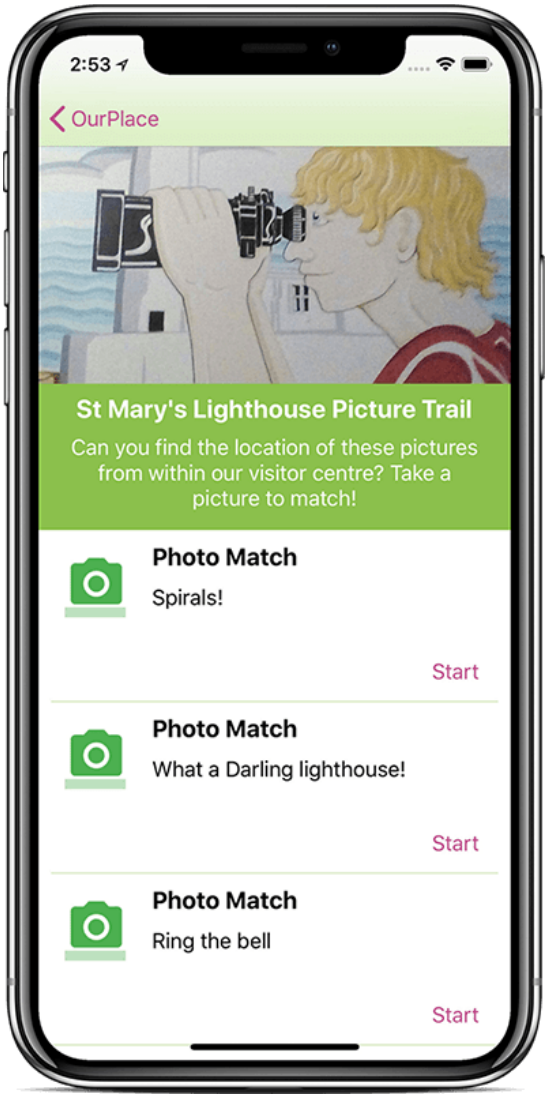

Figure 5.2 A simple Activity in the OurPlace iPhone app. The Activity's image, title and description appear at the top, with Tasks underneath. The Task Type of each Task is made known to the user by displaying its name and icon (i.e. '*Photo Match*'). The screen can scroll vertically if there are more Tasks than can be displayed at once.

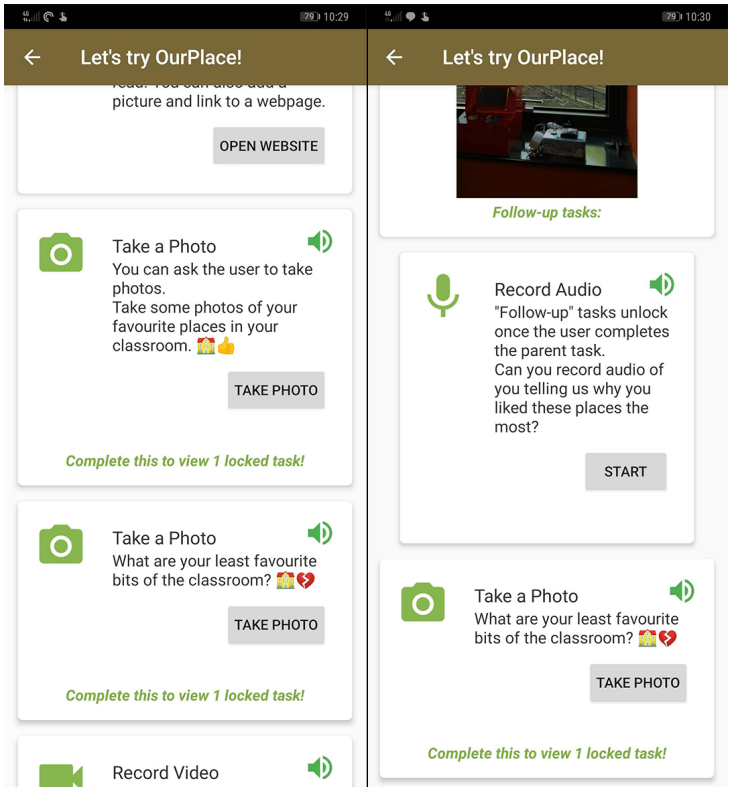

Figure 5.3 An example of how Follow-Up Tasks work. Completing 'parent' Tasks (left) makes any Follow-Up Tasks they might have available to the learner. Follow-Up Tasks are listed below the parent, and appear on slightly smaller cards to make them visually distinct (right).

The OurPlace app also features the concept of 'Follow-Up Tasks', which were also introduced during the re-branding to OurPlace. Follow-Up Tasks act as children to a chosen parent Task, only becoming available when the parent has been marked as completed by the system (Figure 5.3). For example, a Task might ask the learner to take a picture of the item in a museum they found most interesting, and then a Follow-Up Task could ask them to record an audio clip of them explaining what was interesting about it: encouraging students to reflect through the application whilst still being situated in the authentic learning environment (addresses DG5). In order to make learners aware of locked Follow-Up Tasks, a '*Complete this to view X locked tasks!*' message is displayed upon the parent Task (Figure 5.3, left). Once the parent Task has been completed, the message changes to '*Follow-Up Tasks:*' and the child Tasks are listed below the parent (Figure 5.3, right). Follow-Up Tasks appear on slightly smaller cards than their parents in the app's interface. Once completed, Tasks cannot be 'uncompleted' (e.g. by deleting all taken photos), meaning that unlocked Follow-Up Tasks will remain available unless the Activity's progress is completely reset.

5.2.2. Overview of Task Types

Table 5.1 lists all of the Task Types as they are listed to users creating Activities in the OurPlace application. This section goes into more detail about the implementation of each. Unless noted otherwise, the functionality of each Task Type was identical between ParkLearn and OurPlace. All Task Types contain a some sort of textual description or instruction, with a 'text to speech' button which reads the description aloud when pressed (addressing DG4). If a Task has an interaction for the learner to perform, it will either be assigned to an 'action button' (e.g. 'TAKE PHOTO' and 'START' in Figure 5.3) which will navigate to a new screen in the app, or take place on the Activity's main screen (e.g. Multiple Choice and Text Entry in Figure 5.7).

Information

One of the simplest Task Types, this presents the learner with a piece of text to read. Optionally, the Activity author can also choose to include an image to accompany the text, as well as a hyperlink to a related web page. If included, the hyperlink is assigned to the Task's action button, which will open the address in the device's default web browser when pressed (Figure 5.4.a). The ability to assign custom images and arbitrary URLs opens up opportunities for Activity creators to further promote their own materials and transition users onto other platforms (addresses DG3). Because Information Tasks are passive (and the action button is optional) they are marked as completed by default, meaning any Follow-Up Tasks are immediately visible.

Listen to Audio

The learner is given an audio recording to listen to. Tapping the Task's action button will open up a media player screen, where the audio file plays on a loop until closed (Figure 5.4.b). The Task is marked as completed when the media player is closed. As they do not require the reading of text, Listen to Audio Tasks support those who may struggle with reading due to their eyesight or reading comprehension (supporting DG4). Furthermore, they do not require the learner's attention to be actively on the device while listening, allowing fewer distractions from the authentic learning environment (addressing DG5).

Icon	*Name*	*In-App Description*	*Creation Metadata*
	Information	Some additional information about the activity's topic, with an optional accompanying image.	An image (optional) and valid external URL (optional)
	Listen to Audio	Listen to a given audio recording.	An audio file (.mp3)
	Take a Photo	Take a photograph using the device's camera.	None
	Photo Match	Use the camera to match an existing photo.	The photo to match (optional, see details below)
	Draw a Picture	Use the paint tool to draw a picture!	None
	Draw on Photo	Use the paint tool to draw on top of a taken photo!	The image to draw on top of (optional, see details below)
	Record Video	Record a video using the camera.	None
	Record Audio	Record an audio clip using the device's microphone.	None
	Map Marking	Mark your location onto a map.	Minimum and maximum number of locations, plus toggle to restrict to learner's current location
	Location Hunt	Hunt down a given coordinate using a tracking tool!	A location from a Google Map (lat/long)
	Scan the QR Code	Find and scan the correct QR code.	None
	Multiple Choice	Choose an answer from a given set of options.	At least 2 options
	Text Entry	Enter a written response into a text field.	None

Table 5.1 The Task Types available within OurPlace, with their descriptions as shown in the mobile application and the data they require during the Activity creation process (in addition to a written description/instruction).

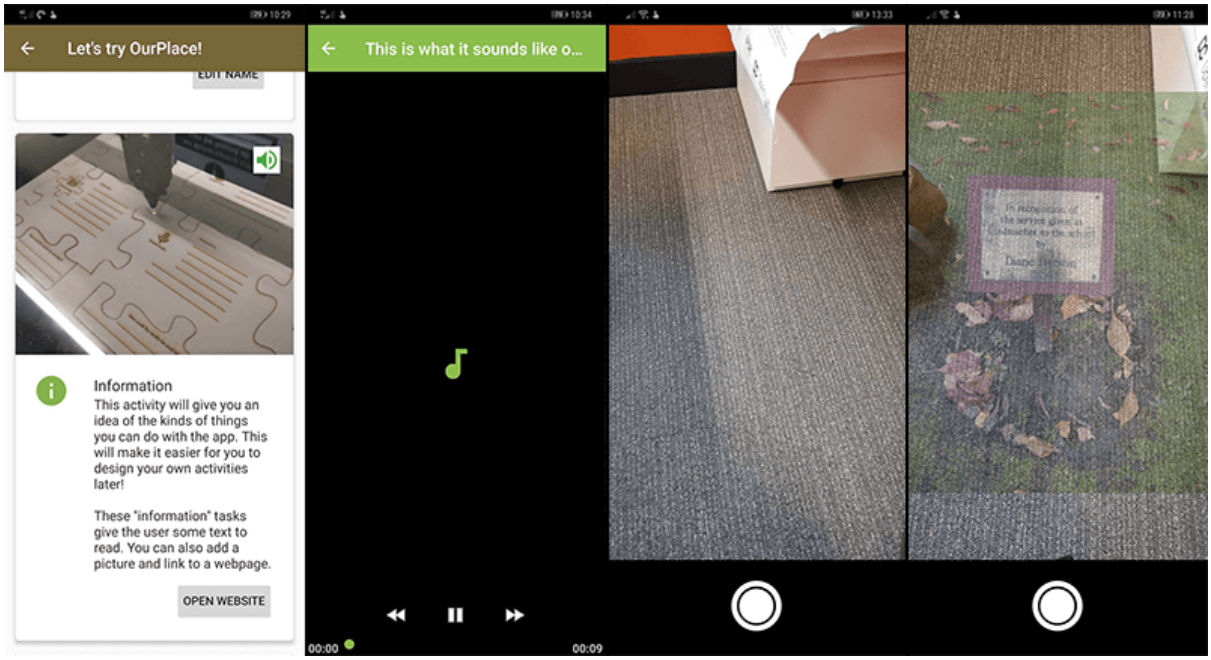

Figure 5.4 Task Types (left to right): a) Information; b) Listen to Audio; c) Take a Photo; d) Photo Match

Take a Photo

This Task Type asks the learner to take one or more photos of a subject. The action button opens up a simple camera screen (Figure 5.4.c). Whilst mobile applications would normally use the device's default camera application, the app's other camera-related Task Types have more complex requirements, requiring custom solutions. For the sake of consistency, that custom camera screen is also used for this simpler interaction (DG4). When a photo is taken, the camera closes and returns to the Activity screen. Multiple photos can be taken, and are listed below the Task's action button (Figure 5.5.a). Tapping one of these will open it in the media viewer screen where the user can see a larger view of the photo, with the option to delete it by tapping a bin icon (Figure 5.5.b). The original ParkLearn app did not have this media viewer screen, however unwanted photos could still be deleted through a 'tap and hold' interaction on the images. Photo Tasks serve as a way to 'capture' glimpses of the physical learning context for later review elsewhere (DG1, DG2), and their 'point and shoot' interaction is easily understood by learners of all ages (DG4).

Photo Match

This is similar to 'Take a Photo', in that the learner is asked to take one or more photos of a subject. However, the camera screen shows a semi-transparent overlay of another image

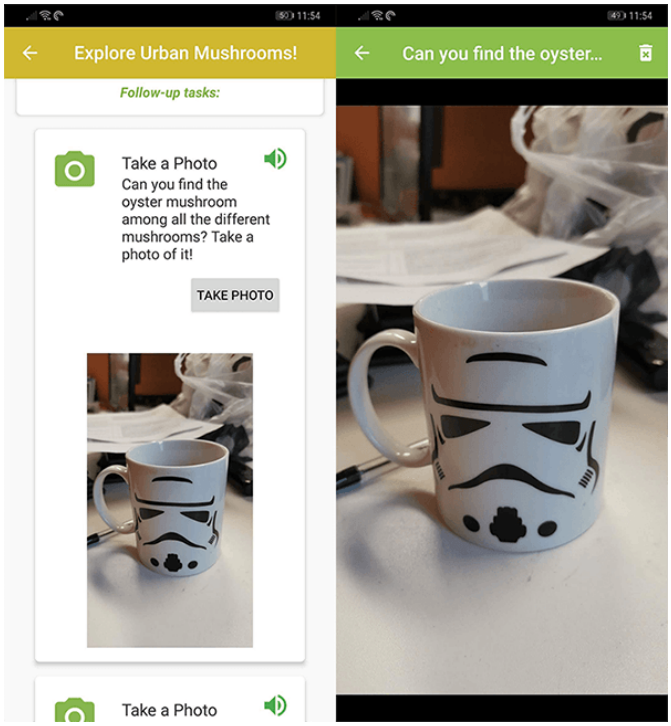

Figure 5.5 (left to right): a) Resulting images from 'Take a Photo' are listed below the Task on the Activity screen. b) Tapping one opens it on the media viewer screen, where the option to delete the item is available.

on top of the camera feed (Figure 5.4.d). The Activity author provides an image of their own choosing (i.e. a photo they have taken or downloaded from the Internet). This extremely basic form of augmented reality is simple enough for users to configure themselves, while still supporting the grounding of the digital content in the physical environment (Javornik et al., 2019). This supports Activity creators in promoting more 'guided' photography-based Tasks, sacrificing learner agency for a more scaffolded experience (supporting DG3).

Draw a Picture

The learner is asked to draw a picture, using a basic painting interface which is launched by tapping the Task's action button. A wide variety of colours can be selected using the selector at the top of the screen, and drawn onto a blank white canvas (Figure 5.6.a). Tapping the save icon will save the drawing as a JPEG file and return to the Activity screen, where it can be viewed/deleted in the same way as photo files. OurPlace introduced the ability to create multiple drawings. While drawings made on a phone screen are inherently of a low fidelity, as an interaction it still offers learners a large degree of creative expression (DG5).

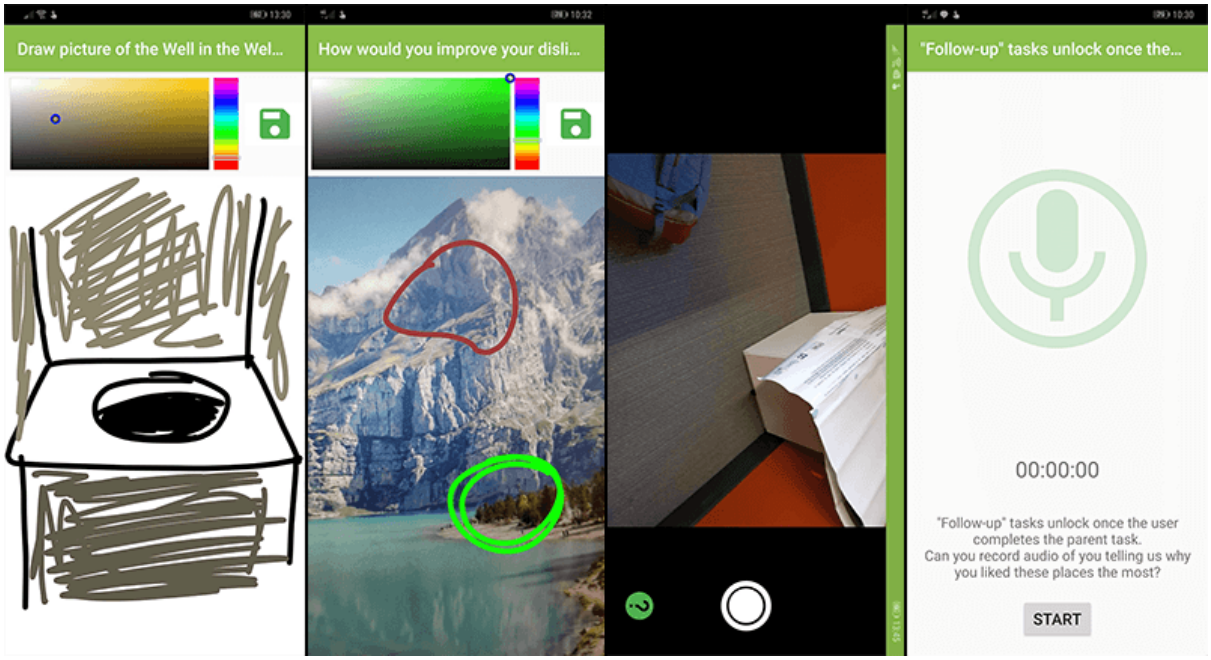

Figure 5.6 Task Types (left to right): a) Draw a Picture; b) Draw on Photo; c) Record Video (rotated); d) Record Audio

Draw on Photo

Functionally the same as 'Draw a Picture', however the blank white canvas is replaced by a supplied image (Figure 5.6.b). The Activity author can either provide an image of their own choosing (e.g. a photo they have taken, or downloaded from the Internet), or—if this is a Follow-Up Task to an appropriate parent, such as a Take a Photo or Photo Match—have the overlay be one of the images taken by the learner in the parent Task. This choice means that the Task Type can either be used to provide scaffolding—similar to the Photo Match Tasks (supporting DG3)—or an even greater degree of learner expression, building and reflecting upon the learner's previously created materials (supporting D5). Images can be viewed and deleted in the same way as other photos and drawings.

Record Video

Learners are asked to record a video of a subject using the camera. The camera screen is locked in the landscape orientation, and features a help button which will show the Task's description/instruction when pressed (Figure 5.6.c). Recording starts when the shutter button is tapped, at which point the button turns red. To minimise storage issues, a custom video recorder screen was implemented, which caps video recordings at 10 minutes in length and

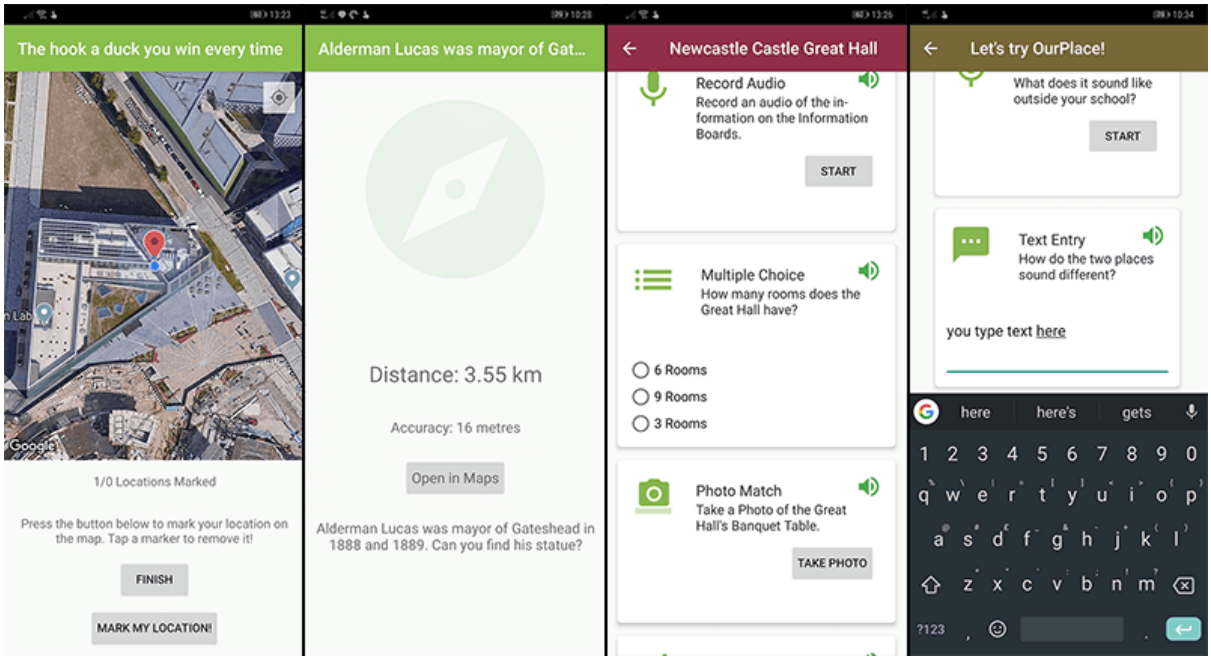

Figure 5.7 Task Types (left to right): a) Map Marking; b) Location Hunt; c) Multiple Choice; d) Text Entry

at a 720p resolution (DG6). When the shutter button is pressed again (or the 10 minutes elapses), the video is saved and the user is returned to the Activity screen. Multiple videos can be recorded, and thumbnails for each are listed below the Task (as with the photo results). Tapping a video file will open it in the media screen, where it can be replayed or deleted if desired.

Record Audio

Learners are asked to record an audio clip using the device's microphone. Tapping the action button opens a separate recording screen, showing a start/stop record button, record timer and the current Task's instruction for easy reference (Figure 5.6.d). After pressing stop to finish the recording, the learner can immediately listen back to it. If satisfied, learners can save the file, which returns them back to the Activity screen. Recorded audio clips are listed below the task: tapping one will open it in the media screen, where it can be replayed and deleted as desired. Audio recordings are a good format for in-situ reflection (DG5), as creating them requires less time, effort, and writing proficiency (DG4), and doesn't completely take learners' attention away from the environment.

Map Marking

This is the only Task Type which requires an active Internet connection during use, as it asks learners to mark a given number of locations onto a Google Map (Figure 5.7.a). The user's current location is shown on the map by a blue dot. Map markers can either be placed on the user's current location, or at custom locations by the learner tapping the map. If they desire, the Activity's author can restrict the learner to only placing markers on their current location, meaning that learners have to physically travel to places they want to mark (DG1, DG3). Learners can delete markers they've placed by tapping them. The Activity author can also configure the minimum and maximum number of markers the learner is required to put down before completing the Task (can be set as unlimited by putting a zero as the maximum). Completing the Task will result in a small, non-interactive version of the map being shown under the Task on the Activity screen. When tapped, this will re-open the full map for editing.

Location Hunt

Learners are asked to track down a target location by observing their device's distance from the target coordinates (Figure 5.7.b) (DG1). A large graphic performs a 'breathing' animation, getting faster/slower as the user gets closer/further away from the target. A beep is also played each time the animation loops, giving the impression of a 'GPS metal detector'. The device's current GPS accuracy (in metres) is also given for context, so that the learner can be aware of poor signal (e.g. if they're indoors). Once the learner is within 10 metres of the target, a pop-up notification is shown notifying them of their arrival, and the Task is marked as completed.

Scan the QR Code

Learners are asked to find and scan a specific QR code, with the Task's instruction ideally acting as a clue to find it. Tapping the action button opens up the application's built-in QR code scanner. Scanning the wrong code shows a failure message ('*That's not it!*'), while finding and scanning the correct code completes the Task. The Activity's author can view and print the generated QR codes from the OurPlace website. This Task Type was introduced in OurPlace, primarily to support Activity authors who wanted to create 'Location Hunt' style Tasks indoors, where GPS might not work properly (DG1, DG3).

Multiple Choice

Learners are asked to choose one of (at least two) different text options. Options are presented as a list of radio buttons on the main Activity screen (Figure 5.7.c). The Task is marked as completed once an item is chosen. While extremely basic, this Task Type was added as it was used frequently within teachers' and park rangers' worksheets (DG3).

Text Entry

Learners are asked to enter some text into a text field on the main Activity screen (Figure 5.7.d) using the device's default virtual keyboard. Virtual keyboard apps vary per device, with some also allowing for 'voice typing', where learners can speak into the microphone for real-time text transcription. Regardless of input method, the Task is marked as completed once at least one character has been entered into the text field.

5.2.3. Completing Activities

Once Activities are opened, they (and their media, such as images and audio) are cached by the application so that they can be accessed without an Internet connection. By default the app caches up to four Activities at a time, cycling them out according to date last accessed. This limit was put in place to avoid taking up too much device storage with old Activities, however it can be increased up to 20 cached Activities in the app's settings (DG6).

Tasks within Activities (with the exception of Follow-Up Tasks, until they are unlocked) can be completed in any order. The learner can tap 'Finish' to complete the Activity at any time, even if there are Tasks which have not been completed. ParkLearn initially required that all Tasks be responded to, however this resulted in teachers and researchers entering 'junk' data in order to upload responses by students who hadn't responded to each Task during a session. After the learner taps Finish, the application checks if there are responses to upload (e.g. entered text, photos, audio clips etc). If there are, these are packaged up and added to an upload queue, and the user's progress through the Activity is reset to allow another learner to start it afresh. This allows for multiple students to use the same device, without having to overwrite each others' work (DG6). Having an upload queue also allows for teachers to upload the student's work on return to the classroom, avoiding the need for costly mobile data plans (DG6). Once the learners' data has been uploaded, the local version of it is deleted to free up storage space.

If the Activity was made by another user, once Finish is tapped the application will also ask the learner if they wish to share their results/creations with the Activity's author. If they agree, the Activity's author will be able to see the uploaded data on the OurPlace website (discussed in Section 5.3). Otherwise, only the learner will be able to see the uploaded data. Making Activity responses private uploads by default supports schools' use of learning materials generated by external communities, while simultaneously preventing the accidental sharing of images of children outside of the school (DG2).

5.2.4. Creating Activities

The entire Activity creation process takes place inside of the OurPlace mobile app. This means no additional equipment is required, and it allows the designer to create Activities in situ if they wish (addresses DG1, DG2, DG5). If the author has access to high quality production hardware and software (e.g. DSLR cameras, studio microphones), they can produce their Activity's media separate from the device and import it into the OurPlace app from external sources (e.g. Google Drive, Dropbox). This means that while Activity creation has a low barrier to entry, those who have the means and inclination to go the extra mile and produce more 'professional' Activities are able to do so (DG3, DG4). This also has the added benefit of users being able to use media that they've downloaded from the Internet (e.g. Google Images). While on a large-scale commercial platform this would likely raise issues around misuse of intellectual property, we decided to overlook the issue due to the small nature of our deployments and lack of monetisation.

To make the experience of creating Activities as consistent as possible, the process uses the same iconography (including the icons shown in Table 5.1) and similar functionality and layouts to the ones seen by learners when completing Activities. For example, as in the Activity 'consumption' view, the Activity's details are shown at the top of the screen, with its Tasks laid out in a list below (as can be seen in Figure 5.9). This means that introducing users to the application through consuming an example Activity will partially prepare them for the creation process (addresses DG4). A full overview of the Activity creation process is mapped out in Figure 5.8, with the in-application version of each stage shown in Figure 5.9. After supplying a title, description and an optional image (Figure 5.9.a), the designer creates the Tasks that make up the Activity. Each Activity requires at least one Task before it can be uploaded. Tasks can be re-ordered by dragging them up or down the list.

Every Task Type requires some form of written instruction/information, but some also require or allow additional customization (addresses DG3). For example, the *Take a Photo* Task Type

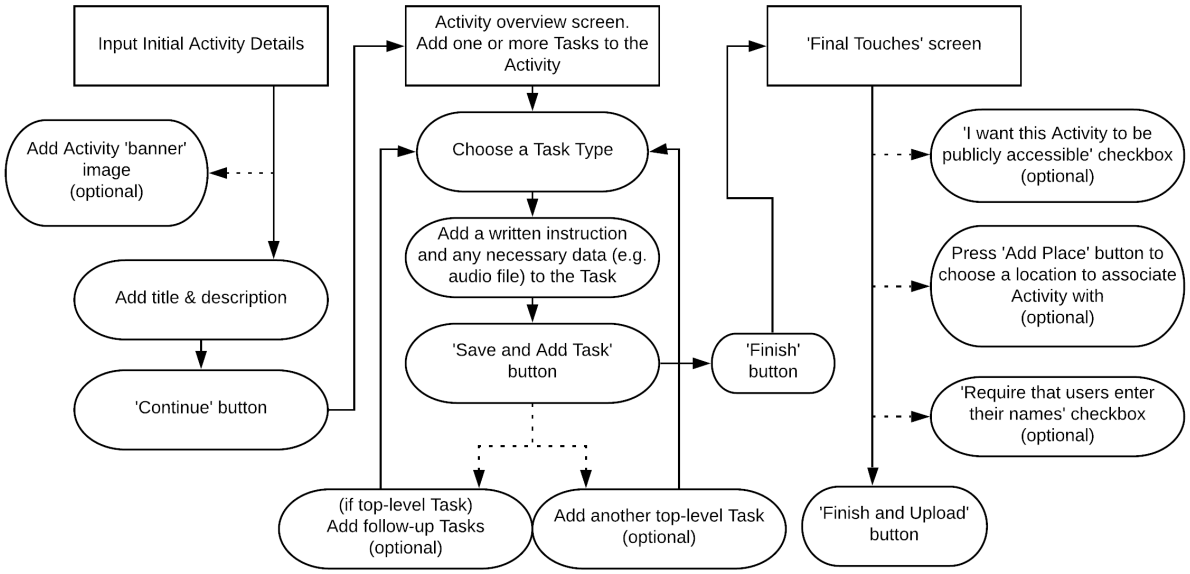

Figure 5.8 A flow diagram of the Activity creation process

only requires a written instruction for the learner to follow (e.g. "Take a photo of the site where the fireworks are launched"—Figure 5.9.d), while a *Location Hunt* also requires the author to mark a location for the learner to find (Figure 5.9.e). Some Task Types require the author to supply some media, which can either be generated through the OurPlace app directly, or imported from another source as noted earlier. The media creation tools are the same as those used when 'consuming' an Activity, again meaning that users who have previously completed an Activity have some understanding of the interface. For example, when creating a *Listen to Audio* Task, the author must supply an audio recording: this can either be imported from an external source (as an MP3 file), or created using the same interface as the *Record Audio* Task Type (Figure 5.6.d). If the author has made a mistake while creating a Task, such as a typo in its instructions, the contents can easily be edited and corrected.

Follow-Up Tasks can be added by simply tapping the 'Add Follow-Up Tasks' button on any Task in the main list. This will open a new screen, where the author can add Follow-Up Tasks to a new list in the same manner as before (Figure 5.9.g). If a top-level Task has Follow-Up Tasks configured for it, the 'Add Follow-Up Tasks' button changes to 'Manage Follow-Up Tasks'.

Once happy with their Activity, the author presses 'Finish' and is shown a 'Final Touches' screen (Figure 5.9.h). Here they can configure some of the metadata attached to their Activity. They can choose whether their Activity should be publicly accessible or private, which will affect how others are able to access it (discussed in Section 5.2.5). Activities are set to public by default, to encourage a greater amount of content to be made accessible on the platform.

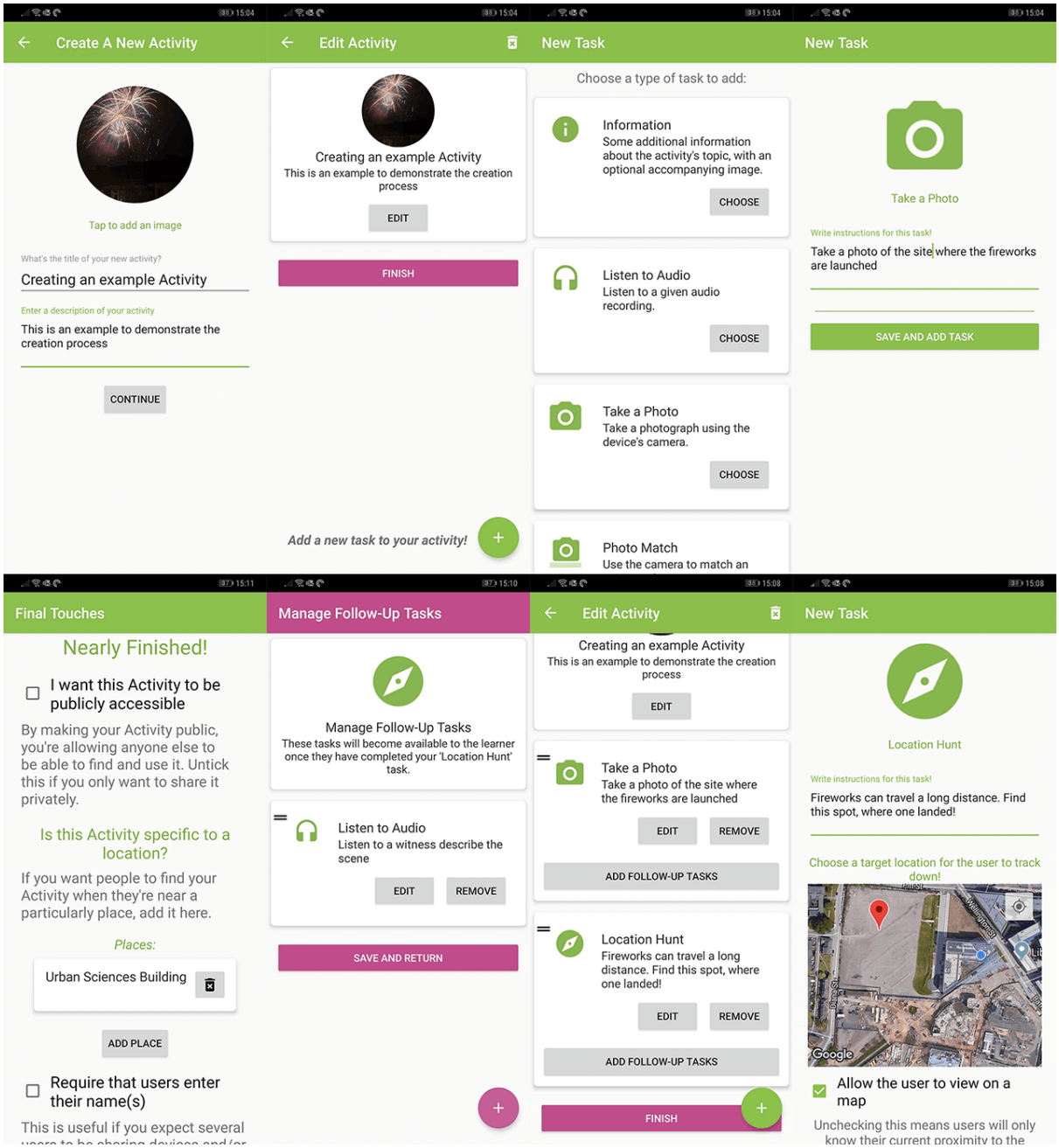

Figure 5.9 Creating an OurPlace Activity (clockwise, from top left): a) Choosing the activity's title, description and image; b) The Activity overview screen; c) Choosing a Task Type to add; d) Adding a basic *Take a Photo* Task, with a description, e) Adding a more complicated *Location Hunt* Task, with description and target coordinates; f) The new Tasks in the Activity overview; g) Adding Follow-Up Tasks to the *Location Hunt*; h) The final touches before uploading

Authors can also choose to associate the Activity with multiple locations (i.e. if the Activity is about that location). Places are selected through the Google Maps app and searching using the Google Places API. Finally, the author is given the option of requiring learners to enter their name before submitting responses to the Activity. This is particularly useful to allow teachers to differentiate between students' submissions when they share devices and/or OurPlace accounts (addresses DG6).

After the author applies these final touches and taps 'Finish and Upload', the Activity is packaged up and added to the upload queue. Once uploaded, users can access their Activities from the 'My Creations' tab on the app's main screen. Here they can view their Activities' share codes (see below), delete them, edit them or open and experience the Activities as a learner. Whilst creating an Activity the author's progress is saved every time a change is made, reducing the chances of progress being lost. Authors can resume the creation of unfinished Activities, meaning that they can be more easily created across several sessions and/or locations (DG2, DG6). However, whilst editing an Activity changes are not cached offline, in order to avoid confusion related to having several versions at once. Instead, the author must make the changes and immediately upload the new Activity.

After an Activity marked 'public' is uploaded, it must be approved by a 'trusted user' (i.e. a researcher) before other users can see it as a public Activity (see Section 5.2.5). Until then, it is treated as if it is private. Activities created by administrators are automatically approved and are immediately made public.

5.2.5. Sharing, Discovering and Launching Creations

In order to promote the use of the OurPlace app in authentic learning contexts (DG1, DG5, DG6) whilst also being adaptable to the various requirements of teachers, learners and place stakeholders (DG2, DG3, DG6), there needed to be a variety of options for content discovery and consumption. Key to our response to this issue was the choice to have the Creation author be in control of whether a Creation is public or private. Once approved by a trusted user, public Creations become visible in other users' Highlights Feed, while authors of private Creations have much more control over who can see them.

The Highlights Feed and Location

Approved public Creations can appear in other users' Highlights Feed. As this tab is shown to all users upon opening the application, it means that many users will potentially see anything

posted onto it. There are two ways that Creations can appear on the Highlights Feed: either by being one of the most recently uploaded pieces of content (and shown in a 'Recently Uploaded' section of the feed), or being associated with a location which the user is close to. If the user has granted OurPlace permission to access their location, the server will return any and all places within 2.5km of the user which have Creations associated with them. These Creations are then listed in separate sections of the Highlights Feed, with one section for each location. This way, the system will always provide the user with some content, but prioritises Creations which have been made nearby (DG1, DG5) without the need for any additional user input (DG4).

Share Codes and QR Codes

All Creations, both public and private, have unique six character 'share codes' associated with them. Authors can see the code for a Creation by tapping it in the 'My Creations' tab, or by going onto the 'Your Activities' section of the OurPlace website. Authors can then share this code with other users. The code can be entered (case insensitive, for ease of use) into the app's search function, which will immediately launch the Creation. Once opened, the Creation is cached so that the code doesn't have to be entered again to re-open it.

QR Codes are also generated for each uploaded Creation, and made available to authors on the OurPlace website. The OurPlace app includes a simple QR code scanner, which will immediately launch a recognised Creation upon a successful scan. If the QR code is scanned on a device outside of the OurPlace app, the device's operating system will suggest that OurPlace be used to open the QR code if it is installed. If the app isn't installed, the user is taken to a web page with some information about the scanned Creation, and instructions for installing the OurPlace app to open it.

As these are the only methods of finding and launching private Creations, authors can have much greater control of who can access them, as well as where and when they do so (DG3). For example, a teacher can show Creations' share/QR codes on their classroom projector, so that students can easily download specific content prior to a school trip (DG2). Place stakeholders could also ensure that a Creation could only be accessed at a particular location by making it private, and featuring a QR code on an interpretation board (DG5).

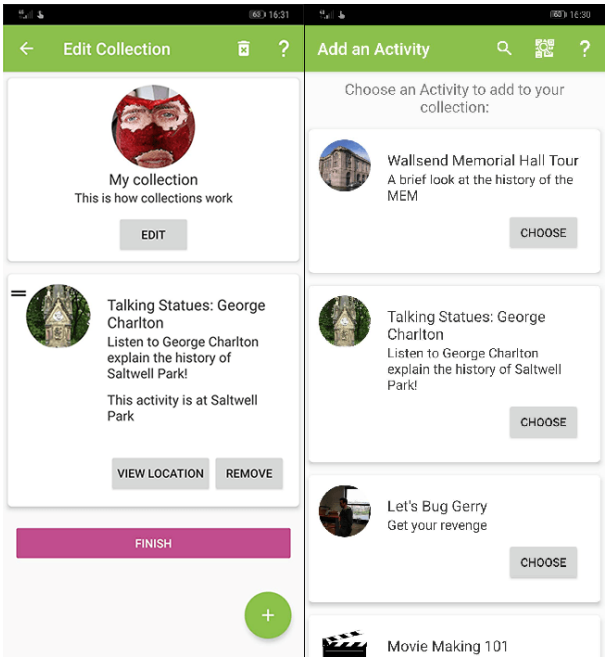

Figure 5.10 Creating an OurPlace Activity Collection. Left to Right: A) The Collection creation screen looks very similar to the interface for Activity creation, with Activities listed instead of Tasks. B) The author's created Activities are listed for easy access, but they can also add other users' Activities by entering a Share Code or scanning a QR Code.

5.2.6. Activity Collections

Late into the project (in response the studies covered in Chapter 6, implemented in time for the Art Trail study detailed in section **??**), the ability to create Collections was added in response to users' feedback. As their name implies, Collections are simply selections of existing Activities which share a commonality. They were added to the app for creations such as trails, where users wanted to have a full Activity's features at each stop, rather than being limited to a *Location Hunt* and Follow-Up Tasks. Having opened a Collection, learners can optionally do a *Location Hunt* to any Activities which have a location associated with them. At the time of writing, only the Android version of OurPlace supports Collections. After the introduction of Collections, the 'My Activities' tab was renamed to 'My Creations'.

Collections are created in a very similar manner to Activities, with some of the screens being identical. A creator can give their Collections a title, description and optional image. Rather than adding Tasks, they add Activities (Figure 5.10.A). When adding an Activity to the Collection, the user is presented with their previously uploaded Activities for easy access (Figure 5.10.B). Should they want to create a Collection which includes other users' created Activities, they can select them either by entering the Activity's Share Code or scanning its QR Code, as they would to open them normally. Once finished adding Activities, users

then note whether the Collection should be publicly accessible, and what locations the Collection should be associated with (the list of places is auto-populated with the selected Activities' associated locations). As Collections are associated with Activities rather than copying/containing them, if an Activity held by a Collection is edited and updated, the Collection will reflect those changes. Collections go through the same approval process as Activities.

5.3. The OurPlace Website

While mobile devices such as phones are very well suited to engaging in out-of-classroom learning contexts due to their portability and multi-functionality, they are not always suitable for productivity in more formal learning contexts (usually due to their small screen sizes and lack of physical keyboard). In order to support the use of students' responses to OurPlace Activities upon return to the classroom (responding to DG2), they needed to be accessible from a desktop/laptop-friendly interface. In response, OurPlace's online server features both a website (for user-facing interactions) and an API (for the app's networking features). These are hosted within the European Economic Area on Microsoft's Azure Cloud infrastructure, using Azure's App Service and Storage systems for computation, networking and blob (file) storage.

The OurPlace website exists primarily as a management tool for the user's OurPlace content. Users can log into the website using the same account as they use for the mobile application, and are able to view their uploaded Activities (at the time of writing, Collections are not yet shown on the website) and responses, as well as responses to their created Activities (access given with the learner's consent). Activities cannot be created or opened through the website, although this functionality has been frequently requested.

Instead, the website is designed to be used for reviewing existing content. The 'Your Activities' page will list all of the user's uploaded Activities (Figure 5.11). When one is clicked, the user can see the Activity's QR and share codes, how many times that page has been accessed (i.e. how many times that QR code has been scanned), and access any QR codes needed to be printed for 'Scan the QR Code' Tasks. The 'Your Uploads' lists all of the user's uploaded responses to Activities (Figure 5.12). If an Activity requires that the learner enter their name before submission, the name will be displayed on the submission's card on this page (useful for when different people will be using the same device/account, addressing DG6). When a submission is clicked, the user is taken to a page where they can view the submission in its entirety. This page shows each Task in the Activity, in a format extremely similar to that

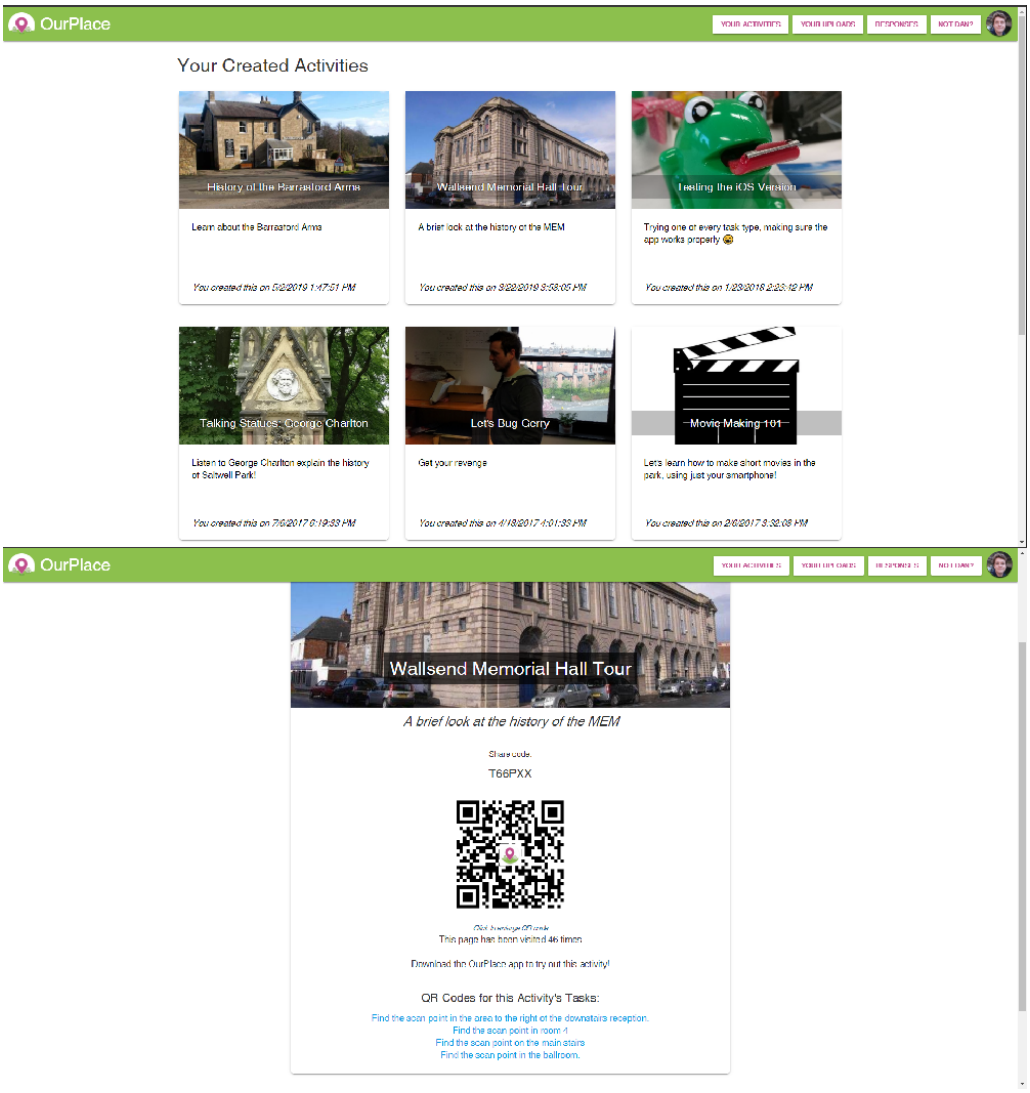

Figure 5.11 Viewing the user's created Activities on the OurPlace website. Top: the user can see all of their uploaded Activities on the website. Bottom: When an Activity is clicked, the user is shown some extra details, including its share code and QR code, as well as links to any QR codes needed for 'Scan the QR Code' Tasks.

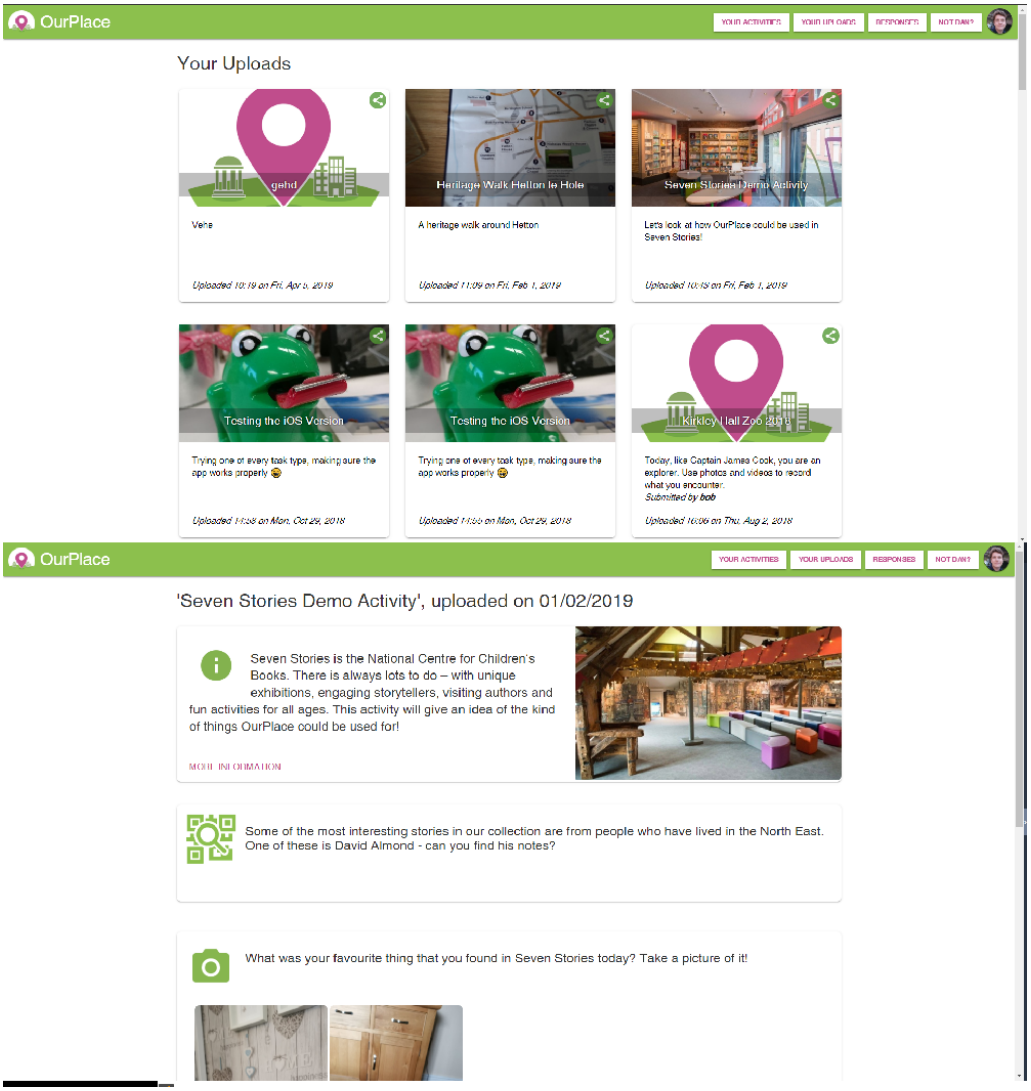

Figure 5.12 Viewing the user's uploaded responses on the OurPlace website. Top: the user can see all of their uploaded responses to Activities. Bottom: When a response is clicked, the user is shown its contents, in a format similar to the OurPlace mobile app.

found in the mobile app (DG4). The page's large elements are designed to be suitable for use on large displays, with the intention of supporting viewing submissions on devices such as classroom projectors (DG2). All submitted text, audio, video, images and map data can be viewed, and the user can enlarge the visual media for a closer look.

A version of this page can also be accessed through the URL supplied by the 'share' icon found on each card on the 'Your Uploads' page. When followed, this 'magic link' will allow anyone to view the submission without needing to be signed into an account—useful for sharing uploaded results with external collaborators, without sharing account access (DG3).

The 'Responses' page is functionally very similar to the 'Your Uploads' page, but lets the user see what other learners have submitted in response to Activities that the user has created. These responses are only made available to the user with the learner's explicit consent, given prior to uploading in the OurPlace app.

5.4. Overview of the Technology

The OurPlace platform is not insignificant, consisting of a smartphone application, a website and an online application programming interface (API). It was decided that in order to support as many schools, groups and individuals as possible, both of the main smartphone/tablet operating systems should be supported (Android and iOS). As a result, some consideration had to be made as to how the platform should be implemented on a technical level. This section covers the more technical decisions that had to be made, and a brief overview of the project's technical implementation.

5.4.1. Use of the Xamarin Framework

While many cross-platform mobile applications rely on implementations such as websites or 'write once, deploy anywhere' technologies, these frequently carried with them functional limitations, performance issues or unpolished user experiences. I wanted the application to provide a high quality experience which conformed to each mobile platform's expected design metaphors, supported access to all of the devices' hardware features and didn't require a constant internet connection, which these options didn't support (at the time). Previously, the solution would be to develop completely 'native' applications, resulting in having to produce software in multiple programming languages: for example, Android applications are usually written in either Java or Kotlin, whereas iPhone apps are written in Objective-C. As I was the only developer on the project, dedicating large amounts of time to learning, developing, iterating and maintaining systems across multiple languages was unrealistic.

In the end, the decision was made to develop the mobile applications using the Xamarin Framework. This framework takes code written in C# and compiles it into 'native' applications, meaning that apps look, feel and act like software written in the different platforms' specific languages. This gave the advantage of sharing the same programming language across both applications, without losing out on any major features and allowing for common code (functionality identical across the two applications, e.g. making requests to the server) to be shared across the projects. To fully capitalise on this code sharing advantage, it was decided

to take this further and produce the website and API in C#. As a result, every component of the OurPlace platform can be opened within the same Visual Studio 'solution', significantly speeding up the development process.

While developing the mobile applications with the Xamarin framework significantly reduced to upfront time investment in the development process, it had trade-offs which became more apparent as the project grew. Having all of the OurPlace code available within one solution (discussed in 5.4.2) was certainly convenient and minimised code duplication, but when combined with Xamarin's more demanding build process it created large performance overheads. This, combined with issues of documentation being in other programming languages (particularly on the iOS application), impeded the development workflow, frequently slowing it to a crawl. At the end of the project, it is difficult to say if significant time was saved by using Xamarin over the two platforms' 'native' development tools. However, anyone considering these options should note that recent developments to Visual Studio and the Xamarin framework have significantly improved performance, which may somewhat mitigate these issues.

5.4.2. The OurPlace Visual Studio Solution

All of the OurPlace code is open source, and can be viewed at https://github.com/GSDan/OurPlace. Using C# and Microsoft's .NET Framework across the OurPlace platform afforded it being accessible within a single Visual Studio solution, split into four smaller component projects: *OurPlace.Common*, *OurPlace.API*, *OurPlace.Android* and *OurPlace.iOS*.

OurPlace.Common This is a .NET Standard 2.0 project, which acts as a 'library' of functions and serves the other projects within the solution, avoiding duplicating large swathes of code. It contains shared data models, interfaces and common core functionality, including managing the apps' local files, authenticating with the API, polling for the latest OurPlace activities and uploading new activities and responses. This is the only project which is referenced from elsewhere in the solution.

OurPlace.API This project uses version 4.6.1 of the .NET Framework, and contains an MVC ASP .NET website, a Web API 2 powered API and a Code First, Entity Framework database. User authentication for the API and website are handled through OWIN OAuth 2.0, supporting user account creation and login through both Google and Facebook. The server, database and file storage are hosted on Microsoft's Azure cloud platform, and deployed directly from

within Visual Studio. All of the website's pages have been designed to work on a wide variety of device types, comfortably supporting phones, tablets, laptops and projectors.

OurPlace.Android This project contains all of the code specific to the Android application. Written in C# using the Xamarin.Android framework, a 'native' Android application is produced upon compilation, supporting devices running Android versions as old as 4.1 (Jelly Bean, 2012) and targeting the latest features found in version 8.1 (Oreo, 2017).

OurPlace.iOS This project contains all of the code specific to the iPhone/iPad application. Written in C# using the Xamarin.iOS framework, a 'native' iOS application is produced upon compilation. The application requires a minimum of iOS 10, which is supported by devices as old as the iPhone 5 (released 2012).

5.5. Summary

In order to create a mobile learning application which could be utilised by both schools and communities for authentic, place-based civic learning, six design goals were created, based on existing literature and preliminary findings. These were that the technology should: 1) utilize local places and communities as learning resources; 2) support seamless outdoor and classroom use; 3) support a variety of pedagogical approaches and stakeholder requirements; 4) support a wide range of user ages and technical expertise; 5) support learning and reflection in authentic learning contexts; and 6) support mobile learning in resource-limited schools.

In response to these design goals, I iterated upon the ParkLearn prototype, eventually creating the OurPlace platform. While the original ParkLearn technology probe only supported users in consuming and responding to hard-coded learning material, the new application supported the creation of new mobile learning activities without the need for additional tools. These 'Activities' are made up of smaller, modular interactions called 'Tasks'. Each Task asks to user to perform an interaction, based on its 'Task Type' (listed in Section 5.2.2). These Task Types use interactions which either promote learner creativity or emulate previously existing learning material. Furthermore, responses to these Activities could be uploaded and viewed on the accompanying OurPlace website, designed for use in classroom activities.

The OurPlace platform responded to the design goals by promoting strong ties to location-based interactions and content; supporting learning activities seamlessly across physical and social contexts, through the use of mobile devices and a desktop website; supporting

various pedagogical and stakeholder requirements by offering a wide variety of potential combinations of interactions and deployment opportunities, while giving users control over who can access their creations; offering a visually simple, consistent interface and user experience; enabling deep reflection and engagement with local knowledge by supporting in-depth responses to (and the creation of) learning material in-situ; and providing measures which support device sharing and offline storage of Activities and responses.

Chapter 6. Community-Led OurPlace Engagements

The original research path of the OurPlace project can be split into two branches: investigating how the application can be used as a seamless, place-based learning tool within formal education contexts; and how it can be used as a platform for civic learning, with place stakeholders sharing knowledge and values to meet their own agendas. This chapter focuses on engagements which meet the latter, describing a multiyear ethnographic study with a local heritage group and the engagements which came as a result of it. The following studies are detailed in this chapter:

Study	***Engagements***	***Purpose***
'Talking Statue'	Site visits, unstructured interviews, technology deployment	Assess application against existing design goals within a real-world context
Heritage Forum Ethnography	Participation in monthly meetings over 3 years; assisted with their conferences and workshops	Gain rich understanding of how community heritage groups run, their challenges and priorities
Heritage Workshop	Interactive design workshop	Gain broader insight into other heritage groups' methods of visitor engagement, attitudes towards and usage of technology
'Places in Transition'	External research project	Case study of usage of OurPlace within other community contexts

Not all of these engagements were formally conducted studies—rather, several of them (for example, 'Talking Statue') existed as formative and exploratory engagements with local communities. These were held not only as a way of evaluating OurPlace, but also to gain a greater understanding of these communities of practice and if and how technologies such as OurPlace could be of benefit to them.

The work covered by section 6.1 was part of a body of work which was peer-reviewed and published at MobileHCI 2018 (Richardson et al., 2018), with the paper being co-authored by Doctors Pradthana Jarusriboonchai, Kyle Montague and Ahmed Kharrufa. This chapter expands on the reports of the community-based deployments in that paper, with the co-

authors having assisted during the writing process, providing feedback and advice on the paper's structure and contribution. The study described in section 6.3.1 was organised and ran by my colleague Bobbie Bailey using the OurPlace platform. At the time of writing, the paper detailing that work is still in preparation (Bailey et al., 2020).

For clarity

During the early engagements covered in this chapter, the OurPlace platform was still called 'ParkLearn', and lacked the Follow-Up Tasks functionality. Otherwise, the apps were functionally very similar—see Chapter 5 for more information. The rebranding of ParkLearn to OurPlace occurred in response to findings covered in section 6.2.4.

6.1. Creating a Talking Statue using ParkLearn

This section details a series of engagements with two members (male and female, aged in their 60s) of a local park's *Friends of X Park* (anonymised) volunteer group. The volunteers were looking to install a 'talking statue' in their park. While this was achieved through the use of the ParkLearn within a few weeks, the engagement led to the development of a multi-year relationship between myself and a local heritage group, of which the male volunteer was a member.

6.1.1. Context

This park is one of the largest and oldest in the area, having opened nearly 150 years ago. It is also one of the most well maintained, receiving significant support from both the *Friends of X Park* volunteer group, as well as other local community groups who organise litter-picking events over Facebook. Being one of the few large parks within its county borough and used for large public events such as fireworks displays, the park also receives considerable ongoing support from the local council, and received nearly £10 million for restoration at the turn of the millennium. The park features a number of pieces of historical and cultural interest, including a number of statues and modern art sculptures. It also boasts eleven listed structures, which marks them as being of '*special architectural and historic interest, and also brings [them] under the consideration of the planning system, so that [they] can be protected for future generations*' (Historic England, 2020).

The two volunteers approached the Parks2026 (discussed in Section 4.2.1) research group, following engagements unrelated to this project. They had seen the Talking Statues project (Sing, 2017), and wanted to produce their own version for their park. These 'talking statues' had used QR codes to launch a mobile-friendly website, where celebrity narrations would inform the user about the history of the statue and the local area. The volunteers wanted to make their own version, built upon an existing monument of a key figure of their park's history. They wanted this statue to share its story with visitors, encourage them to further explore the park and even to join the volunteer group. However, as the volunteers had very limited technical knowledge and funds, a bespoke digital technology (in the same vein as the original Talking Statues project) seemed inaccessible to them. A physically wired system would have also been too expensive, and would also have interfered with the monument's status as a listed historical structure. They had hoped that our research group would see this as an opportunity to create a new research project. When this didn't happen, I recognised that the newly expanded ParkLearn app was a viable alternative.

As the volunteers had approached me, I decided that rather than treat the following engagements as a formal, structured study, I would instead view it as a collaborative exercise between myself and the participants—in-line with practitioner consultation and co-design previously demonstrated in the early stages of design-based research practices (Herrington et al., 2009). During this collaboration we could achieve mutually beneficial but different goals: the volunteers wished to install a new technology into the park, which could not only draw visitors but also highlight the efforts of the volunteer group, potentially gaining them some more support. Meanwhile, I was keen to use the opportunity as a pilot study exploring if and how ParkLearn was a suitable tool for this kind of real-world grassroots application, and if it could be seen to fulfill DG1 (*Utilize local places and communities as learning resources*), DG3 (*Support a variety of pedagogical approaches and stakeholder requirements*) and DG4 (*Support a wide range of user ages and technical expertise*).

6.1.2. Creating the Installation

I met with the volunteers at their park to introduce them to the ParkLearn app and discuss what they would want out of the project. While they were satisfied with the app's functionality, they were most taken by the lack of infrastructure needed by the app and the potential speed of its deployment: they had previously anticipated the installation to take over a year to develop and deploy, whereas the ParkLearn Activity could be ready almost immediately. Furthermore, they were very surprised by the lack of cost—something which was a major concern, as the volunteer group existed on a shoestring budget. With these reasons in mind,

the volunteers decided to create the installation using the app. This was to be the first deployment of ParkLearn 'in the wild'.

I was keen to have the volunteers attempt to do as much of the process by themselves as possible, giving my help when it was requested. This was not only to gain a more accurate understand of the application's use, but also because I was aware that the volunteers' domain knowledge and passion far exceeded my own, and this would likely be reflected in the finished content.

While the process of creating an Activity can normally be completed in only a couple of minutes, the talking statue Activity took several weeks to prepare. This was partly down to the need to decide upon and generate content: the volunteers needed to write a script for what the statue should say, and also decide on what else should be included in the Activity. Several drafts were written, balancing the desire to add historical detail with the need to keep the audio recordings short and accessible. The volunteers also considered ways in which they could advertise their volunteer group to interested visitors—as well as inform learners about the park's history, they also wanted to spread awareness of their group's efforts, and how it could be supported. Finally, the volunteers also needed to decide how the Activity should be accessed by visitors. They decided that in order to access the Activity, the user should have to be at the statue in person. This meant that the Activity would have to be set to private, with QR Code scan points provided at the statue itself. Another factor which delayed the deployment was that the volunteers applied for funding from the local council to print Foamex signs for the QR code, which would be stronger and more weather resistant than laminated paper. They also required permission from the council to feature these signs semi-permanently in the park.

The final 'talking statue' Activity was created at the female volunteer's house, with my help (while both had a base level of digital literacy, neither were hugely comfortable with using new technologies—neither had actually installed an app before, despite both owning Android smartphones). The Activity featured a narration of the park's history from the perspective of the statue, written and read by the male volunteer. This was recorded directly into the app for a *Listen to Audio* Task (Figure 6.1.A). The volunteers were keen for a written transcript of the narration to also be included, so that the Activity would be accessible to those who are hard of hearing. To this end, the speech was transcribed using *Information* Tasks, which also featured historical photos of the park and external links to the volunteer group's website. Finally, the Activity used *Location Hunt* Tasks to guide the learner to eight of the park's most easily accessible listed structures, acting as a simple walking trail (unfortunately as ParkLearn lacked Follow-Up Tasks, no additional content could be unlocked upon arrival).

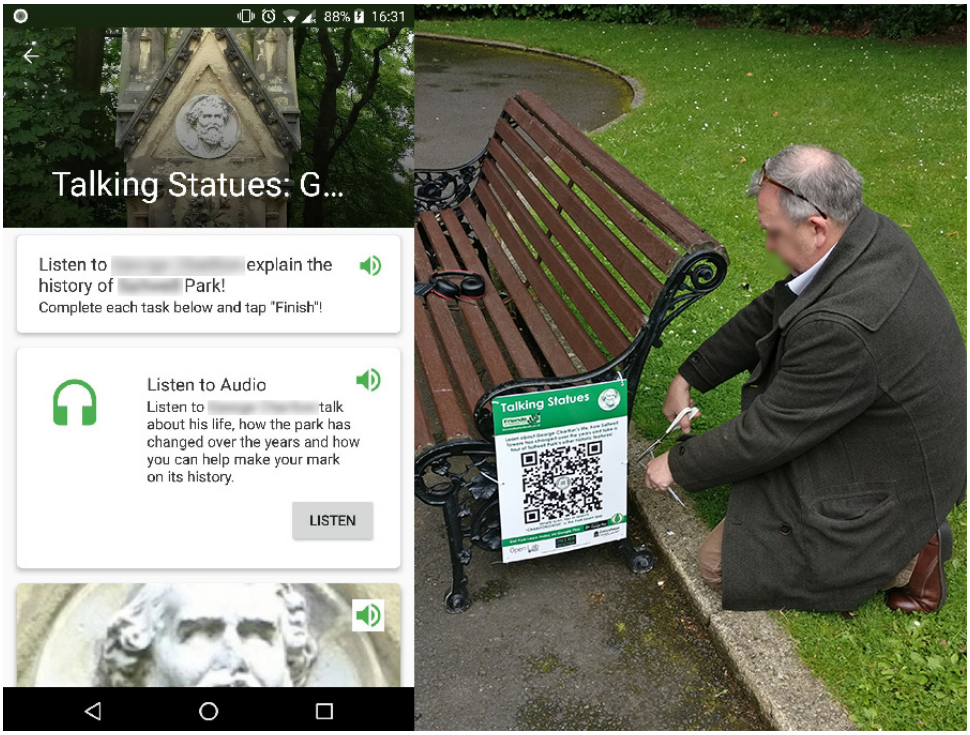

Figure 6.1 Left to right: A) The 'Talking Statue' ParkLearn Activity. B) The male park volunteer installing Foamex signs featuring the Activity's QR code.

The Foamex signs were printed with a simple design featuring the Activity's QR code (supplied by the ParkLearn website), and attached to benches near the statue using zip ties (Figure 6.1.B). By making the Activity 'private' and using these signs, the volunteers could ensure that only people near the statue could launch the Activity. As this meant people would have to be present in the park to use it, they treated the statue as an attraction: something that would raise the profile of the park and encourage people to visit. They printed posters to advertise the project to the surrounding community, and even talked to the local press.

After the launch of the installation, the volunteers were eager for regular updates regarding its usage by park visitors. To facilitate, I updated the ParkLearn website to show the number of times each Activity had been scanned (95 scans in the first 30 days). They were proud of the installation, and demoed it to several volunteer groups from other parks in the area. The signs are still in place over two years later (although one was stolen, and had to be replaced), with around 1200 scans logged.

Figure 6.2 The final ParkLearn 'Talking Statue' installation.

6.1.3. Discussion

As a pilot deployment, the 'Talking Statue' deployment can be seen as being a success—both from the perspective of it as an assessment of the performance of the ParkLearn platform, and how it met the park volunteers' needs as stakeholders.

The engagements demonstrated the potential for mobile learning platforms such as ParkLearn to utilise local places and their communities as learning resources (DG1). Through using the app to design and distribute their own bespoke digital learning materials, the volunteers were able to highlight and share local expert knowledge (i.e. their knowledge of the park's history) as well as promote their values and own political agendas (i.e. the value they place into the park as a place, the efforts that their community of practice go to to sustain it, and highlighting opportunities for people to get involved).

With regard to supporting stakeholder requirements (DG2), ParkLearn supported the volunteers by enabling them to create a digital multimedia instalment with minimal institutional support. In this case, the local council were only involved as the volunteers required permission to put up the scan points. Furthermore, due to the use of pre-existing technology, the total cost of the installation was around £50 (the cost of producing the signs). The talking

statue launched in the same summer in which it was conceived, rather than the original target launch date of the following year. These factors all exceeded the stakeholders' initial desires, as they had expected the solution to require significant time and money, ergo requiring monetary support (and with it, oversight) from local government.

Meanwhile, the application's support for a wide range of user ages and technical expertise (DG4) was less clear cut. Due a lack of confidence with mobile applications, the volunteers asked that I directly assist with the Activity's creation. With my help, the actual creation of the Activity took less than an hour, and the volunteers were keen to try the Activity on their own devices. However, when asked they noted that if they were to create another Activity, they would prefer to have me there to assist. Further engagements were necessary to determine if this was an issue with the application's design, or if this was a case of digital platforms (such as Android) being intimidating to individuals who had little experience with them.

6.2. An Ethnography within the Heritage Forum

Following the success of the Talking Statue, I was invited to attend a meeting of a grassroots heritage group (referred to from here on by the pseudonym 'Heritage Forum', or 'HF') which was being hosted in the same park. The male park volunteer was a member of this forum, and wanted to thank me for enabling the talking statue project and introduce me to the other members. This meeting spawned a several-year relationship with the Heritage Forum.

6.2.1. An Overview of the Heritage Forum

The Heritage Forum was formed in 2015 by representatives of local heritage groups active within the North-East of England, and exists as an alliance of key heritage bodies and individuals active within the region. The HF is volunteer-based, and exists as a registered charity. Motivated by austerity politics restricting the amount of public funding dedicated to the protection and preservation of heritage, the Forum celebrates that the region was at the forefront of world development during the period of the Industrial Revolution, and '*seeks to make a tangible and significant impact on the regional environment to the benefit of those who live and work there*'.

The Forum is particularly focused on the heritage surrounding the period of the Industrial Revolution, a time of technical innovation and intense population and economic growth during the 18th and 19th centuries. The North-East of England at this time was recognised for being extremely influential in terms of new technologies: notable figures from the region

include George Stephenson (who built the world's first public inter-city railway line), Joseph Swan (invented the incandescent light bulb, with Newcastle boasting to have the first street to be lit by electric light) and William Armstrong (an industrialist whose house featured the world's first hydroelectric power station). The region also has a significant industrial heritage, particularly surrounding shipbuilding, glass production, coal mining and iron, steel and chemical manufacturing.

The HF performs several functions. They have organised several conferences, which are attended by local heritage community groups and institutions, history enthusiasts, historians and representatives from local government. These conferences feature heritage-related keynote speakers, presentations, interactive workshops, stalls and opportunities for groups to network. The Forum also runs an initiative which provides advice, mentorship and practical support to local heritage groups. The initiative's marketing material notes:

> *"We can provide advice and support for heritage and history groups wishing to better understand, protect and improve access to a historic structure or place in their community, as well as mentoring in areas such as project development, understanding significance, conservation, understanding statutory and planning frameworks, applying for funding, setting up a charity, developing partnerships, creating interpretation, learning programmes and more."*

The Forum is largely made up of working and retired professionals (including architects and town planners), history enthusiasts and academics. The number of members in regular attendance varies, with typically between 5-12 attending the monthly meetings. While the majority of members who were retirees and history enthusiasts were male (and obviously of retirement age), the working professionals skewed largely female, with most in their twenties and thirties. However, the main figures (e.g. the Chair) of the Forum, and the individuals most likely to attend every meeting, were male.

6.2.2. My Engagements with the Heritage Forum

As a result of the talking statue project, I was invited to hold a 'workshop' about my work at the Heritage Forum's 2017 conference. While this was labelled as a workshop, it actually consisted of a slot within a series of guest presentations/lectures. When feedback from many conference attendees suggested a greater emphasis on interactivity, the Forum asked if I would like to host a full interactive workshop, due to my prior experience in running such

workshops for research. The details of this workshop—and a discussion of the findings that came of it—are covered in Section 6.2.4.

Following this workshop, I gradually became a more permanent member of the Forum, attending the monthly meetings and several social events over the course of the next two years. As well as covering progress on members' projects, these meetings also concerned the organisation of the Forum's public events, including workshops and conferences. As well as the workshop discussed in Section 6.2.4, I helped plan and run a public Heritage Forum workshop aimed at how volunteer groups could better utilise social media for engagement (delivered by a colleague as a part of their research project relating to community volunteer groups' usage of social media platforms); assisted in the organisation of the Forum's 2018 conference (which I helped restructure to support the existence of longer, interactive workshops); ran a short workshop at this conference (discussed in Section A.3.5); and helped the group move towards holding smaller and more regular 'Meetup' style engagements, rather than large annual conferences (the first of these meetups was unfortunately delayed past the time of writing, due to the 2020 coronavirus pandemic).

6.2.3. Reflections on the Heritage Forum

Through reflecting upon these personal encounters with the Heritage Forum over the course of the last three years, I made some observations which I feel are worthy of some discussion. These relate to the group's role, effectiveness and sustainability within the UK's current socio-economic and political environment, as well as some of my concerns relating to how representative such groups are of the wider communities they serve.

The Localism Act in Action

The Heritage Forum exists as an interesting case study when viewed under the lens of the impact of David Cameron's 'Big Society' policies (discussed in Section 2.4). The group formed out of a perceived necessity for civic action to protect and develop artefacts of the North East's heritage, due to a lack of investment from local government. The Forum's existence could actually be viewed as the Localism Act working as intended—local community members coming together through volunteerism, sharing their expertise to assist others in effecting local societal change through interactions with local government systems. The Forum's services, which utilise and share their gathered specialist knowledge, aim to counteract the issues faced with regards to citizens not having the skills or domain knowledge to put the Localism

Act to effective use (BBC Sunday Politics, 2013), and compensate for the government's lack of provisioned resources and opportunities for self-education (Ben Rogers, 2010).

That said, I argue that the Forum instead highlights the inherent flaws of a state reliance upon volunteerism as a response to societal issues. While I believe that the Heritage Forum does valuable work, the sections below briefly cover some of the experiences which led to my belief that it is a poor substitution for properly funded equivalent public services.

Concerns around Sustainability

The Forum's monthly meetings generally consisted of members discussing any progress that they had made in respect to heritage projects they are engaging with (for example, one member was coordinating with the local council to create a publicly accessible area around an old water well). Due to the nature of volunteer work and the levels of bureaucracy involved with local authorities and planning permission, progress tended to be slow with nearly all projects that the Forum engaged with (the well project had started underway when I first joined the group, and at the time of writing still only exists on paper). This lack of progress inevitably led to many of the monthly discussions being repetitious, leading some of the group to think of the meetings as being "all talk and no action".

Towards the end of my engagements with the Forum, I had noticed that several of the members had started showing signs of weariness of it, partly born of frustration with the group's lack of progress and tendency to quibble on minutia without making lasting decisions. I believe this may be one reason for why the 'Talking Statue' project appealed to them: the ParkLearn app allowed individual members to take action and create an installation, with little need for prolonged engagement with bureaucratic institutions such as the Forum or local authorities.

The group's decision to move away from holding large conference events and instead towards smaller, more frequent community engagements was prompted by the recognition of how much of the responsibility of organising the conferences had been placed on relatively few members. This had been another factor which led to a few key members feeling particularly fatigued. This may point towards a lack of sustainability with self-organised community groups of this kind: the volatile nature of volunteering means that frequently the work may be shouldered unevenly. While this was most visible in the organisation of the Forum's annual conference, it was also evident in several other areas, including website maintenance, financial management, minute-taking and meeting organisation.

During my time with the Forum, several members had to leave: either due to health issues, relocation, or simply a lack of time to continue volunteering. The loss of members who had shouldered any significant amount of responsibility often put the Forum in disarray, unprepared to cope. This has led me to believe that just because a group has a large amount of domain knowledge, that doesn't mean that they know how to organise a sustainable organisation: at least, not one which can not only put that knowledge into action, but do so in a way which isn't dependent on retaining a small set of key individuals.

Volunteerism and Representation

A lack of representation accurate to surrounding demographics is another of the other prevalent issues surrounding a reliance upon volunteerism, and was also evident within the forum. Active participation in the group is somewhat gated by the necessity of having the free time to do so, inadvertently resulting in one's ability to actively participate largely being dependent on age and/or privilege (for example, I saw no people of colour attend Forum meetings). Thus, the only community voices able to effect change in local heritage through the Forum were those who could afford to volunteer their time to do so. While there was an active push within the Forum to get more young people involved, there didn't seem to be much reflection about other aspects of diversity and representation. While it may be unfair to hold volunteer groups to the same diversity standards as employers (they aren't going to turn down willing volunteers, and can't force anyone of particular demographics *to* volunteer), the resulting under-representation of underprivileged demographics is the same: something which could potentially be easier to mitigate if publicly funded, due to a lessened reliance upon volunteerism.

Despite these issues and obstacles, the Heritage Forum has managed to engage and network with smaller community groups, local institutions and local government in an effort to conserve and highlight local heritage—work which would likely not have been done had the group not existed. The sections below cover engagements made possible through collaboration with the Heritage Forum, investigating how mobile learning technologies could assist groups such as the HF and its partners in achieving their objectives. These findings are then discussed as a whole in section 6.4.

6.2.4. Heritage Forum ParkLearn Workshop

I coordinated with the HF to organise and deliver a large interactive workshop, aiming to promote discussions between heritage groups and volunteers as to how they could utilise mobile learning tools such as ParkLearn in their projects.

Context & Participants

Following my contribution to their 2017 conference and keen to respond to attendees' requests for more involved workshops, the Heritage Forum asked if I would be willing to host a full interactive workshop which would offer participants hands-on introductions to ParkLearn. Keen to engage with a larger pool of place stakeholders, I agreed. The workshop was held on the Newcastle University campus, over the course of two hours on a weekday evening.

The workshop was publicly advertised by the Forum through their website and mailing list, using the Eventbrite website for online sign-ups. Mostly thanks to the Forum's significant database of contact details, the workshop attracted 48 attendees from across the North of England. Participants included academics from several universities, volunteers at local heritage projects, management staff from heritage related organisations such as museums, and individuals who worked within relevant sectors of local government. Due to the high number of participants, three other Open Lab researchers and several members of the Heritage Forum helped facilitate the running of the workshop.

Methodology

Upon arriving, participants were asked to sign in using an attendance sheet (which had been pre-populated by the Eventbrite participant list), given an information sheet about the project, and asked to sign a consent form which requested permission to record audio and take photographs of the participants. Participants sat around tables of 4-8 people, with each table having a mix of participants representing at least two groups/institutions (usually more, due to most groups only being represented by one or two participants). Most participants appeared to not know each other. Each table was provided several copies of a document featuring the following prompts and questions:

> *'Introduce yourselves! What are your interests? Which heritage group(s) are you involved with?'*

'What current interactions do visitors have with yours space? (e.g. tours, interpretation boards, social media, website, school groups, special events)'

'Have a play with the app! Can you think of ways in which a technology such as ParkLearn could be used to highlight the value of your heritage sites?'

'What creative activities could you imagine with these tools? (e.g. recording visitors' memories of an area as a child, photographs of what visitors most enjoyed, videos of visitors role-playing what life may have been like)'

'What could you do with these creations after visitors upload them?'

Rather than gain specific feedback on the ParkLearn app as a tool, these questions aimed to prompt discussions around the participants' projects, the ways in which they engage with visitors, their attitudes towards technology and how they could see mobile learning playing a role within their projects. To further promote and contextualise discussions, each table was supplied with at least one tablet device (Figure 6.3). These tablets had ParkLearn open, with several example Activities pre-loaded. Each table also featured an audio recorder and one of the workshop facilitators, who aimed to keep conversations moving and answer any practical questions that the participants had.

After a brief introduction by the chair of the Heritage Forum, I gave a short presentation which introduced the project: its goals, the app and how it functioned, and an example of how it had so far been used through the Talking Statue deployment. Following this, participants were asked to introduce themselves in their groups, and use the provided sheets as prompts for discussion about their work and the potential role of technology within it. Participants were also encouraged to try creating their own Activities using the app's authoring tools.

Discussions on each table were audio recorded and later reviewed. Due to the large amount of audio recorded (around 12 hours), conversations were selectively transcribed to record interesting highlights, and then processed through inductive thematic analysis with exploratory, line-by-line coding.

Workshop Findings

Thematic analysis of the transcribed audio resulted in three core themes being developed: '*volunteerism and ownership of place*', '*augmenting space to highlight place*' and '*engagement and sustainability*'. The results reported below pertain to these themes, for later discussion in section 6.4.

Figure 6.3 Participants discuss how they could utilise mobile learning apps during the Heritage Forum ParkLearn workshop.

Volunteerism and Ownership of Place

Due to the austerity measures which had been put in place, responsibility of keeping the participants' sites in operable condition had frequently been left to local volunteers. Counter-intuitively, participants claimed that this had been encouraged through funding channels being made available to volunteer organisations, but not local authorities:

> *'They've gotten rid of most of their parks team anyway. The position we're in, in many areas, is that local parks are just not being taken care of. It's all volunteer based now. We've been told that as a volunteer group, a 'friends of the park' group, we can access some funding which the local authority can't.' - Workshop Participant 4*

While the participants agreed that they would prefer that the spaces be properly funded by local authorities, one reported positive outcome of volunteerism was the benefits that it can bring to the volunteers themselves. Several participants (of a variety of ages) talked about how volunteering in these spaces had given them opportunities for socialising, day-to-day structure and even boosted their self-confidence:

'Seeing what it's done for the volunteers as well has been fantastic. I started as someone who wasn't working, wasn't confident, and now my job is to have as much fun as possible down there.' - Workshop Participant 1

Some participants noted that local authorities' attitudes towards some of these sites seemed to change after the volunteers' work had started paying off and the sites were drawing in visitors and income:

'At one point it was something that the city council wanted nothing to do with, it was a liability for them. But now it generates a reasonable income, and wherever you go, people go "Ooh, I didn't know about that, it was great."' - Workshop Participant 2

One participant in their 20s argued that while they enjoyed volunteering, they had struggled to get other young people to join. They noted that while the austerity measures rely on volunteerism, many young people find the current economic environment too hostile to be able to afford to work unpaid:

'There's a large student population in Newcastle, so we're trying to figure out how to cater to them, and how we secure the next generation of volunteers. Cos my generation can't really afford to volunteer—we can't really afford to pay rent, let alone volunteer. So, it's figuring out how we're gonna make it sustainable. - Workshop Participant 3

Augmenting Space to Highlight Place

There were numerous instances of participants noting that elements of space which were frequently seen as being without value were often elements which reflected social infrastructures and helped form a place's character. One volunteer referred to the value of their site's graffiti, noting it as a part of the local heritage which could be shared through the ParkLearn app:

'We've got interpretation boards above ground, but they get covered in graffiti. [considers] ...We've also got a load of graffiti, and it would be amazing to have [the app] talk to it. We've got little bits of heritage all over the valley, and it would be amazing to tie this into that, so people could take more self-guided tours.' - Workshop Participant 4

Another participant noted concern about how making some of these spaces safe for public use could potentially sanitize these characteristics out of existence:

> *'If we tried to secure funding and make parts of it accessible, it would actually lose quite a lot of its charm, its history. There's old bits of park benches still down there... there's graffiti not just from the war, but there's graffiti from when someone took a Margaret in for her birthday in 1968 and wrote on the wall about it. So it gets added to all the time, and we just go in periodically to check that no-one's died down there.' - Workshop Participant 2*

Also highlighted was the fact that these elements of place were often less visible—another participant describes how a group worked with a local school and surrounding residents to create a WW1 history trail, with residents' houses being many of the points of interest:

> *'A group has created what they've called a poppy walk, where they've recorded the 400 World War One casualties that came from the town, and a hundred of their residences are still standing. They've put these resin, bronze poppies [on the buildings]. And they've created this app, so when you come to the property, it says 'this is where lance corporal so and so lived, he was killed on...', and you get that. They did that with school children from a local secondary school.' - Workshop Participant 5*

Instead of collaborating with community members to physically alter space, another participant discussed using digital technologies to create their own layer of place infrastructure which no one else could interfere with:

> *'We have only one blue [commemorative] plaque in the area, and we're looking to identify potential individuals, events or places that would warrant one. The idea I've come up with is to create virtual blue plaques—that way, I can create as many as I like, without arguing over 'well I don't like him', and all the rest of it. So I'm obviously now thinking to put this app with it. So I'll go the virtual route first of all, that way I can create as many as I like, and then present them to the local population to ask who they want as a physical plaque.' - Workshop Participant 6*

The participant noted that due to the passage of time, the space being augmented may have significantly diverged from the space that existed at the time of the heritage being highlighted:

'The issue with a new build town, is that you don't have the buildings to put [commemorative plaques] on. So if you find someone who was important in 1850, well... where he was important is now long gone.' - Workshop Participant 5

Conversely, some of the heritage which participants wanted to highlight would still be particularly relevant to current versions of space and place, simply due to its continued influence upon the surrounding communities. For example, a participant suggested that the *Record Audio* and *Listen to Audio* Task Types could be used to share local music originating from the 1984-1985 miners' strikes:

'For example, I'm a song writer. We could have had people sing songs into that app. And then they could have cited where the song originated, and stuff around the miners' strike, things like that.' - Workshop Participant 7

Engagement and Sustainability

Another key talking point was the importance of engagement with site visitors—be that the local community, tourism or schools. There were commonly negative opinions given of 'traditional' styles of visitor engagement, such as interpretation boards (in-situ signs, displaying relevant text and images) and even traditional tour guides. There was recognition that while these styles of visitor engagement were often appreciated by enthusiasts, they were unlikely to engage new demographics:

'We have the interpretation boards, but people don't want to read reams and reams of text... Some people do, but you can cater for both.' - Workshop Participant 6

These traditional engagements were seen as being particularly uninteresting to children, as they would want more varied and interactive elements, rather than being simply passive experiences:

'I was taken to a lot of historic sites when I was a child, but I was never really engaged with—I was just looking at things, reading things. There was no engagement.' - Workshop Participant 3

Some of the participants' groups had reconfigured their previously traditional content to drive greater engagement with their space. One participant noted that their new style of

tours helped ground the visitors' experiences of place, promoting empathy with the space's previous stakeholders through use of role-play and more interactive elements which brought the history 'to life':

> *'It's so much fun—when I started, we had the two hour heritage tour and had the odd school group in. But now we're doing more things with props, dressing up, at Halloween we turn all the lights off... and they meet characters who lived and died in the area, so everything we do has that historical twist on it, and it means I get to run up and down the tunnel with a fake bottle of wee, spitting it at people. People like that grisly bit, so I like to make sure people leave thinking "I'm really glad I'm alive now, that I do the job I do now."' - Workshop Participant 2*

More common was a desire to embrace new digital technologies, and integrate them into the visitor experience. Having a digital presence was seen as particularly important for engaging with younger audiences and visiting schools:

> *'We've got social media and a website, we do loads of work with schools, and we're doing a lot more special events than we were. Trying to capture the younger demographic.' - Workshop Participant 7*

Beyond technologies such as social media and having a website (which were seen as being fairly attainable), several groups were looking for solutions for digital, in-situ experiences. These often would act as alternatives to the teaching materials (e.g. worksheets) usually offered by the sites to visiting schools. Solutions to this were seen as less obvious than simply having a web and social media presence, and several groups saw ParkLearn as a potential option for delivering interactive educational digital content:

> *'A lot of schools don't want worksheets, pen and paper. They want the kids to be more hands-on, interactive. But something like this, being able to record audio, take pictures... I'm actually trying to set up a geocaching, or map-type activity, so this could actually work really well. I've been struggling to find a way of delivering that sort of thing.' - Workshop Participant 6*

Several participants were inspired by how the park volunteers used audio recordings in their 'Talking Statue':

'We're looking at this, and thinking instead of a tour guide talking, having this, be more interactive. Have the actual miners do the talking.' - Workshop Participant 8

In a departure from these more passive learning experiences, one participant noted that a number of ParkLearn's available Task Types are more generative. They recognised that materials that students produced during site engagements could be used in classroom activities upon return to the school, as part of larger ongoing projects:

'If you were doing a project at the park, you could gather a lot of pictures, audio, whatever it might be, and if you can take that back to school you can use that as a basis of your project.' - Workshop Participant 5

However, there was also some skepticism (or even disappointment) around the application. The name 'ParkLearn' was initially off-putting, due to it seemingly being limited to use in local parks. Furthermore, rather than see ParkLearn as a new way of doing authentic place-based learning, some participants noted that the Activity structure was akin to traditional worksheets. They worried that this would result in shallow learning experiences, with the application just acting as a digital coat of paint on top of a dated teaching method. However, they also noted that the Activity creator could be the limiting factor, with the creator simply mimicking the learning materials that they already have experience with:

"One thing that worries me, is that it feels like a worksheet. [...] Feels a bit like one of those tick box interactions you get on a school trip. [...] But is it just that you think worksheet, so you make one?" - Workshop Participant 9

Another participant recalled how a site's bespoke application—which had been hugely expensive to produce—had seen very little uptake by visitors, and viewed it as a waste of resources:

'I had to do something similar to this, and the company had already developed an app that they were using at another reservoir down south. It was all Beatrix Potter audio, video, stories for a walk around the reservoir, and it triggered as you walked around. And they spent... thousands developing this. Six people downloaded it.' - Workshop Participant 10

On another table, a participant shared that their group were in meetings with software development studios, investigating how much a bespoke application aimed at engaging children with their project would cost:

Figure 6.4 The ParkLearn logo (left) was updated updated to the OurPlace logo (right), moving focus away from nature and instead onto people's lived experiences in place.

> *'Our initial thought was to use augmented reality, and pick out 20 or so points of interest around the quay and develop an app. For example, you want to the statue that we just erected, point your phone at it, and all sorts of information would pop up—including audio, or pictures that would tell you how it was made, who built it, how the money was raised and that kind of thing. So this seemed like a good place to start, we had a couple of meetings about augmented reality. We know it will work, but it's quite pricey, expensive to develop. We were quoted around £30,000.' - Workshop Participant 11*

Workshop Outcomes and Rebranding to OurPlace

This workshop was considered to be a great success by the Heritage Forum, who had previously done little in the way on interactive events of this nature. Partially as a result of its success it solidified my membership of the group, and kindled an ongoing relationship between the Forum and Open Lab as a research group.

Following the concerns raised by several participants in this workshop, I decided to rebrand the platform. While 'ParkLearn' was well suited for the previous engagements with park rangers and volunteers, the workshop highlighted that there was a demand for applications such as this in contexts other than parks. In these contexts, the ParkLearn branding was seen as off-putting due to its lack of contextual relevance, with many of these sites being urban or not associated with nature.

Eventually the name 'OurPlace' was settled upon, to reflect the platform's focus on enabling stakeholders to share their interpretations of place with others. It also moved the platform away from being explicitly about education, which may encourage older audiences to engage, who might have otherwise written it off as for children. The application's colour scheme and logo were updated, moving away from the previous brand's focus on nature and towards one which instead focused on the lived environment (Figure 6.4).

Following the workshop, several of the participants went on to independently use the OurPlace application at their own sites (detailed in section 6.3). I also held follow-up meetings with the participant group who were interested in making augmented reality experiences for their site, and wanted to know more about OurPlace. However, eventually they decided to go ahead and commission the development of a bespoke application instead.

6.3. Other Uses of OurPlace by Community Groups

Following the Heritage Forum workshops, several groups were interested in using the OurPlace app at their sites. While a number of these groups did not end up using OurPlace at their sites, several did adopt the app and created their own Activities. This section will give some brief examples of how the OurPlace app has been successfully used by various community groups to promote the places in which they operate. As these were not formal studies, they aren't reported on as such here. Rather, they have been included in the Appendix (section A.3) to serve as evidence of how place-based mobile learning platforms such as OurPlace can be used by local community groups. Groups who used the application included:

- A railway museum (A.3.1)
- Staff managing a lighthouse (A.3.2)
- A community railway partnership (A.3.3)
- Volunteers running modern art trails (A.3.4)

6.3.1. 'Places in Transition' Study

In addition to these examples, OurPlace was used by a community group in a separate research project (awaiting publication) led by Bobbie Bailey. It has been included here as not only does the project serve as a case study highlighting the need for low-cost digital tools

to be available to volunteer groups, but also as an example which will be referenced in a later discussion in section 9.3: regarding how the introduction of such technologies can have unforeseen consequences which we designers should be aware of.

The 'Places in Transition' project aimed to explore how some of the technologies which have been blamed for the degradation of high streets and urban centres (through the changing of residents' economic and social habits—i.e. use of online shopping, social media, streaming video consumption) could be harnessed to highlight the value of these places, and encourage people to re-evaluate their relationships with them. The research team worked in collaboration with a particular Business Improvement District (BID): a non-profit organisation which aims to revitalise its local town centre by working in partnership with local businesses and the surrounding community, particularly focusing on culture through restoration efforts and the organisation of public events.

The research team co-created an OurPlace Activity with the BID, utilising the application as a medium to digitise the existing walking tours of the town centre which had been designed by a local community interest group. The research team note that the Activity acted as a technology probe, designed to '*enable participants to contribute their own stories of [the town], with the aim of creating a platform for residents to express their civic pride and build upon people's lived experiences and sense of attachment to place.*' Furthermore, they saw the use of OurPlace as an example of how the BID could use existing technologies to create discussion and raise awareness around local assets, and how such technologies could help nurture place-making between residents and their local urban centre.

The app's *Photo Match* Task Type was utilised by the BID to contextualise the future development of the area, visualising planning decisions using basic augmented reality. The research team posited that this could be developed further to allow residents to contribute their own opinions and visions of the area's development. The researchers also found that the BID saw opportunity in OurPlace as a way of promoting experience-led approaches, engaging people during cultural events and highlighting the town's assets. The application's location-based Task Types were seen as being particularly valuable, with the Activity making use of *Location Hunt* and Follow-Up Tasks to highlight local history and attractions in a more interactive and 'fun' way. The Activity also used a *Map Marking* Task, challenging people to discover parts of the town that were seldom visited. This Task's description read:

> *'Find at least 5 of [the town]'s many hidden alleys, yards and small streets! There are loads of small lanes, yards and alleyways and streets in [the town] to discover,*

all with their own unique charm and are full of wonderful independent shops, bars and restaurants. Rediscover as many as you can!'

In this way, the BID saw the digital tools such as OurPlace as a way to provide modern ways to highlight forgotten place assets to the local community. They perceived that modern solutions to these issues required the use of digital tools, noting that technology is something that they '*would have to use*'. They also believed that it could help with engaging with younger generations, and hoped that these generations would go on to value and take care of the town centre. Furthermore, OurPlace was seen as more economically viable than manually running tours, as it didn't rely on the availability of an expert to conduct it.

6.4. Discussion: Place-based Mobile Learning Platforms for Communities of Volunteers

This section covers the points for discussion raised by the findings and observations from the engagements throughout this chapter, including the Heritage Forum workshops and community deployments. Through an inductive thematic analysis with exploratory, line-by-line coding of the combined field notes and transcriptions of this chapter's engagements, the following themes were developed: *'Volunteerism and Ownership of Place'*, *'Augmenting Space to Highlight Place'*, and *'Engagement and Sustainability'*.

Volunteerism and Ownership of Place

While the stakeholders that these studies engaged with worked within a wide variety of physical contexts (including mines, lighthouses, museums and parks) and roles (from volunteers, to tour guides and IT managers), they shared a relatively common set of desires—engaging with new (and particularly younger) audiences. This commonality of agendas aligns with the findings of Chapter 4, where the park rangers were keen to demonstrate the civic value of the places they cared about to new visitors. That study found that the stakeholders hoped that by giving visitors an appreciation for their spaces and the work that goes into maintaining them, visitors would gain some sense of ownership and responsibility for them, perhaps even leading into active participation in their upkeep. Of course, the most sustainable route to this would be for younger generations to become place stakeholders, ensuring that the places would be supported in the future. Many of the community groups that we engaged with saw mobile technology as a promising entryway to engaging and encouraging place-making in younger audiences. For example, several participants mentioned how they had noticed that

Pokémon Go had brought new audiences to their sites, and had been looking at how they could utilise similar technologies to engage with elements of *place* as well as space.

As discussed earlier, austerity measures had resulted in a large number of public parks and other spaces losing funding for maintenance services. As a result, the responsibility of keeping these places in operable condition had frequently been left to local volunteers. Counter-intuitively, workshop participants claimed that this had been encouraged through funding channels being made available to volunteer organisations, but not local authorities. However, some of the workshop participants noted that they had struggled to recruit volunteers from younger generations, reportedly due to their lack of disposable income and how the current economic environment was too hostile for many to justify unpaid work. This seems to point to an unfortunate situation where conservative policies (both fiscally and socially) have worked against each other: austerity politics and the 'Big Society' frequently rely on volunteerism and local action by citizens, but stagnant wages and crippling austerity measures have meant that an increasing number of people are unable to afford to volunteer.

For those who *were* able to work at these sites, the experience seemed to be rewarding and helped encourage place-making. It was clear that many of the participants had strong relationships with the sites in which they worked, and cared about not only the heritage that could be found in those places, but how it could be preserved in the future. This seemed especially true of participants who were volunteering at their sites, rather than paid employees. It seems likely that the participants' experiences with volunteering have been a major contributing factor to them having such strong relationships with the places in which they volunteer. These relationships with the spaces also seemed to be mutually beneficial—volunteers are offered structure and opportunities for socialising, and places benefit from greater appreciation, leading to care and attention. As these relationships developed, some found that they seemed to value the spaces more than other stakeholders—including the local government. Participants noted that this only seemed to change when the volunteers' efforts had led to sites becoming economically viable, making them more attractive to local authorities. Until sites reached that point, there seemed to be the impression that they were under-appreciated, with only the groups such as those volunteering ascribing significant value to them.

I argue that such findings cement the value in mobile learning platforms which support grassroots volunteers in sharing their local knowledge and values in place. Not only can such technologies be used as educational resources and place-making mediums by a place's visitors and newcomers, but the processes of creating and sharing mobile learning resources could also offer new infrastructure through which one's relationship with place can develop.

Combining Giaccardi's cross-media interactions and McCarthy's framing of place-making as the development of a two-way 'conversation-like' relationship, such technologies can offer novel ways of exploring and articulating people's relationships with place: supporting the building of these mutually beneficial relationships through a dialogical 'living practice' (Giaccardi et al., 2008; McCarthy and Wright, 2005).

Augmenting Space to Highlight Place

The participants' relationships with space also frequently appeared to come with an appreciation for the different ways in which these spaces had been used by different stakeholders over time, even the ways which would traditionally be seen as anti-social or even destructive. There seemed to be a desire to highlight these factors, potentially to share their value with others who might not immediately appreciate them. Examples of this included one workshop participant highlighting the social value of graffiti as a part of the local heritage at their site—an element of place which is often seen as being unsightly or uncultured.

Conversely, these 'imperfections' of space—typically signs of life from former stakeholders—were seen to add to the character of place. In a way, these pieces of evidence of how the spaces have been previously used form a new layer of place infrastructure, which evolves over time and helps give each place unique identities and meaning. One of the participants noted concern about how making some of these spaces safe for public use could potentially have a negative impact, sanitizing the elements which give a place its charm and historical character. This highlighted a tension for those maintaining the sites: having to choose between encouraging greater use and appreciation of space, and preserving what makes it special to them. This tension mirrors that found during Crivellaro's study, during which the volunteers initiated a form of social curation—wanting to share the value they held in places which had 'unsavoury' elements which were in danger of being expunged, without also sacrificing authenticity (Crivellaro et al., 2016).

For these reasons, it may be important to consider where and when mobile learning interventions are suitable: while they may be useful as tools to highlight particular aspects of place which otherwise may go unrecognised or underappreciated (e.g. the graffiti), they may also be detrimental to the sense of place, or intrusive on the people who live there. While Relph warned about the dangers of sanitisation leading to inauthentic, 'Disneyfied' experiences (Relph, 2018), highlighting these less desirable features of space and place should also not be done without any critical consideration of the potential consequences. Similarly, we should be aware of technology's impact on space, even when the content being highlighted

to visitors is unlikely to be perceived as negative. An obvious recent example would be users of the Pokémon Go app intruding on private property and socially sensitive areas (such as historical landmarks and graveyards), to the point of a class action lawsuit being filed against its creators (Marder, 2016).

In a similar vein, another workshop participant suggested the use of ParkLearn as a platform for recording and sharing music concerning the 1980s miners' strikes. These strikes were hugely divisive at the time, and the subsequent closing of the mines resulted in many impoverished communities. These events were clearly hugely influential on many places as they exist today, and so stand as an important part of their heritage. This also stands as an excellent example of how mobile learning platforms such as ParkLearn can be used by local stakeholders to share local knowledge, culture and political values as educational resources. That said, the issues surrounding the miners' strikes remain extremely emotional and relevant to this day: for example, in 2004 a murder was claimed to be the result of an argument about the strikes (The Independent, 2004), and many of the pro-strike areas voted heavily to leave the European Union in the 2016 'Brexit' referendum (Daily Post, 2017). This is not to suggest that such histories and values should not be shared, but that designers of technologies which support community-generated civic learning material should be aware that stakeholders may have strong and conflicting views on a place's social infrastructure which—as outsiders—we may not fully appreciate the implications of. As a practical issue for system designers, there exists the possibility for topics to appear innocuous to most, but deeply emotional to a place's stakeholders—a factor which would likely allow submissions to slip past most content filters and misused. In the worst cases, this may allow for abuse and 'trolling' in space and place: combining the intrusive spatial issues of Pokémon Go with emotional stakeholder topics.

This of course doesn't mean that the use of mobile learning applications in community areas can't or shouldn't be done when handled tactfully. As one workshop participant noted through their example of the World War 1 history trail, these engagements can be created as a collaborative community effort. While far less emotional and controversial of an example, it highlights the importance of community collaboration and stakeholders' consent when creating digital and physical infrastructures within their place of interest. In that instance, by working with homeowners and local schools, the group were able to modify the physical elements of space in order to highlight properties of place, which could then be further explored through a mobile learning technology.

However, another participant argued that reaching consensus on this kind of collaboration can be a lengthy and tedious process, and that independently creating digital infrastructure

could be a way of subverting it. They proposed that they could use mobile technologies such as ParkLearn to subvert the process for choosing the subjects for commemorative plaques, creating digital instances of their favourites for more convincing proposals to the community. The participant also noted that as they rely upon the physical infrastructure of space, they are somewhat dependent on that infrastructure remaining constant over time. For example, over the course of decades or centuries, the house in which an important figure lived could have been demolished. However, place does not always change as readily as space: events in a place's past—both positive and negative—can themselves form layers of infrastructure and contribute strongly to its identity. By their nature, mobile learning technologies could highlight elements of place in a manner separate from the limitations of space. While the physical commemorative plaques were limited by such changes, the non-corporeal nature of digital installations meant that the digital versions—which were fully under the participant's control—would be able to be deployed, regardless of the current state of the space in question. In this regard, having digital authorship capabilities gave the participant an advantage in expressing their world-view and performing active citizenship.

This highlighted the existence of a interconnected, three-way relationship between technology, place, and the physical space that the groups worked within. Some of these existed simply as space presenting logistical issues (e.g. not being able to get mobile signal at a remote site) which would affect the performance of the technology, leading to the need for workarounds such as pre-loading content or running local servers. More interestingly, however, is the possibility for technology to be used to subvert the relationship between space and place. While space changes over time—potentially to the point where it may no longer reflect the memories of place—digital artefacts do not have this restriction: as they exist independent of physical space, they are not limited by it. Finally, I also found that several groups were hesitant about the open nature of the OurPlace app, and didn't like the idea that anyone could create Activities about their spaces. These groups felt protective over their site's image and reputation, and weren't comfortable with not being in control of all digital materials that were associated with their site. This hints towards an interesting tension between the 'official' interpretations of place and those of the surrounding community, and how digital mediums can decouple the ownership and control of space and place. This was again reflected in the creation of digital commemorative plaques—the participant was able to subvert the usual channels and create their own plaques in a digital medium, taking control of the process without the need for choices to be sanctioned by the community.

Engagement and Sustainability

A common theme in the workshop discussions was the desire to move away from (or at least offer more than) traditional engagement methods in an effort to capture and retain new audiences. This included more interactive or dramatised tours, the use of social media platforms, and more hands-on interactions with schools who had previously been using pen and paper activities. For this reason, several groups were inspired by the park volunteers' talking statue project: many participants saw it as an opportunity to help bring their interpretation and exhibits to life in a manner similar to the other group's use of role-play, but without the need for staff to be on hand for every visitor. Furthermore, there was a recognition that this could allow for more authentic learning experiences, as it would support them providing audio recordings of the place's actual stakeholders (or at least dramatisations of them).

While there was a desire (or even the sense of necessity) from many participants in these studies to have mobile learning technologies at their sites, practicalities frequently came between these community groups and the integration of technology. For example, by their nature some spaces were fragile or socially sensitive, and couldn't support permanent signage for interpretation or QR codes. Additionally, there was a large variation in the degree of technical literacy that could be found in each group. Interactive technologies beyond websites and social media were seen to be generally less attainable due to their comparative complexity. While some were clearly comfortable with digital technology, others had very little experience and were reluctant to even try engaging, limiting their representation in any created digital artefacts.

The groups we engaged with also had a wide variation in the amount of funding they had access to. While some groups were in a position to be able to consider spending significant amounts of money, others were asking the volunteers to contribute towards tea and biscuits. This affected everything from access to smart devices (e.g. could visiting school groups be supplied with tablets?) to the creation of the software itself. As a result, there was a general appreciation of ParkLearn's generalisability, as it allowed groups to apply it to their own sites without the need for developing bespoke software. There were several participants who noted concern over the sustainability of these expensive bespoke systems, providing anecdotes of them not being utilised by visitors enough to justify their upfront and ongoing costs. These participants rejected the adage of 'build it and they will come', making such investments a sizable risk. As a result, several participants posited that the low-risk nature of a platform such as ParkLearn made it appealing, even if it could not offer the same level of customisation as a bespoke piece of software.

In some groups, there also seemed to be a lack of critical assessment in how the introduction of technology would benefit their project. It was interesting to find that these groups were still willing to risk large amounts of money in order to create custom software, when it was unlikely that it would see much uptake. On the most extreme end of this was the group considering funding the development of a premium application full of cutting-edge technology, at the cost of £30,000. Particularly in smaller sites, the amount of money spent per engaged user is likely to be relatively high—especially when an application is limited to only work at one particular site. This led me to speculate that engagement with the application itself was a secondary concern, and that having a bespoke piece of software (particular one with elements as 'in vogue' as augmented or virtual reality) was more of a symbol of prestige, or a differentiating factor from other sites. The perceived need to integrate mobile technology and the potential lack of visitor engagement with it existed as a tension for many groups, one that most seemed to manage by simply minimising the amount of financial risk they were exposed to.

Finally, the 'Places in Transition' study also highlighted the potential for mobile learning technologies such as OurPlace to be seen as 'replacements' for the more expensive in-person interactions with community experts. While this could also be argued to be a factor in the app's usage in the modern art trail, in that case the technology was seen as a supplementary tool, which could either augment the existing tour or act as a back-up should the guide not be available. As I noted in Section 2.4, there exists a danger that tools designed to support communities coping with austerity measures could be utilised in a manner which supports the austerity measures themselves: propping them up by taking pressure off of public services through the use of volunteerism, automation and DIY approaches. The potential for OurPlace to be used in this way is regrettable, but unfortunately I can't see a way around it. Instead, I can only promote the ways that the application has been used by these participants as intended: giving stakeholders new platforms for sharing their value of place, highlighting local resources and assets in ways which can appeal to new audiences.

6.5. Summary

This research highlighted how place stakeholders perceived a need to utilise new (particularly mobile) digital technologies to attract new, younger audiences—typically in an effort to promote place-making and, eventually, volunteering. However, due to ongoing social contexts, these stakeholders typically existed as volunteer groups with little funding and technical expertise. By their nature, if these volunteer groups had any digital assets (e.g. website), they were also frequently dependant on a core set of specialised individual members, with little planning for sustainability with skill sharing and duplication.

As such, many were receptive to using low cost, approachable and non-destructive 'off the shelf' solutions such as OurPlace to share their knowledge and platform their agendas as place stakeholders. An example of this was shown in the 'Talking Statue' deployment, where local volunteers used ParkLearn to have a statue narrate their park's history and highlight the work of the volunteer group. Through ParkLearn, the volunteers were able to take control of the process, independently creating a digital multimedia instalment with minimal interaction or financial support from the local council. Multiple other heritage groups made their own OurPlace Activities for similar reasons.

Analysis of participant discussions held during Heritage Forum engagements resulted in the development of several themes: '*volunteerism and ownership of place*' (where volunteering tended to be mutually beneficial for both the place and the volunteer, leading to strong place attachment), '*augmenting space to highlight place*' (using technology in space to highlight the value of place, particularly elements which are underappreciated, problematic or controversial) and '*engagement and sustainability*' (the recognised need for engaging new audiences in ways which are more exciting yet still affordable, with the eventual goal of acquiring new volunteers). Finally, further reflections noted the prestige attached to the integration of cutting edge technology in sites (regardless of it being a questionable value proposition), and issues surrounding the interconnected, three-way relationship between technology, place, and physical space: where the degrees of separation between the three prompted questions of ownership, and allowed for the subversion of space when reflecting upon place.

Chapter 7. Teacher-Led OurPlace Engagements in Schools

As well as investigating how mobile learning platforms such as OurPlace could be used by community experts and stakeholders for sharing their knowledge and values, I was also interested in exploring if and how such tools could work within a formal education context. To this end, at the same time as working with the community heritage groups, I also worked with teachers to investigate the use of ParkLearn as a seamless, place-based learning tool and garnering feedback as to how the application could be improved. This involved a longitudinal study with a local primary school, several one-off studies with other schools in the area using OurPlace for a shorter period of time, as well as the use of OurPlace within other researchers' school-based projects. This chapter covers the following studies:

Study	***Engagements***	***Purpose***
Longitudinal Study with a Primary School	Visits to the school, unstructured and semi-structured interviews, 11 technology deployments in classroom and on school trips	Assess and further develop application against existing design goals within a real-world context
'Sense Explorers'	Technology deployment in both classroom and on school trip	Assess against design goals; investigate use of OurPlace as one component within a larger project
'Tyne Fresh'	External research project, technology deployment in both classroom and on school trip	Investigate creation of OurPlace activities as student-teacher collaboration, use of OurPlace as one component within a larger project

As some of these studies were running concurrently with the community engagements covered in chapter 6, the application still existed as 'ParkLearn' for a large number of them, without the features and re-branding of 'OurPlace'. Over the course of the longitudinal study, several other, shorter engagements were held with other schools in the North East of England, during which teachers and other researchers created ParkLearn/OurPlace Activities for school

students. For brevity, details of one such engagement has been included in section A.4 rather than here.

The longitudinal study was a part of a body of work which was peer-reviewed and published at MobileHCI 2018 (Richardson et al., 2018), with the paper being co-authored by Doctors Pradthana Jarusriboonchai, Kyle Montague and Ahmed Kharrufa. Dr Jarusriboonchai assisted with the fieldwork and data analysis of findings described in section 7.1, and all three co-authors advised on the paper's structure and contributions. Sections 7.2 and 7.2 describe and comment on the findings of studies held by Sean Peacock and Sebastian Prost, respectively, in which OurPlace was used with schools during other research projects. I was present for the use of OurPlace during engagements in the former, but not the latter.

7.1. Longitudinal Study with a Primary School

I was put into contact with a teacher at a local primary school (School 1) through a co-researcher, Dr Jarusriboonchai, who was working with them on a different research project. Aiming to further develop and evaluate the ParkLearn application according to the design goals (DGs) covered in Section 5.1 and the project's design-based research approach, I worked with this teacher (Teacher 1, taught Year 4—ages 6-7) for a period of roughly one year, using ParkLearn multiple times on school trips, in the classroom and on the school's grounds. I also worked with another teacher (Teacher 2, Year 6—ages 10-11) in the same school, although this was limited due to examination pressures.

The following sections will outline the common context and methodology used throughout the engagements of this extended study, as well as the Activities and responses submitted by the teachers and students. The results across these various engagements will then be presented for combined discussion.

7.1.1. Study Context

School 1 is situated in one of the most economically deprived areas of England: the ward in which the school sits features the highest crime rate within the constituency, 26% of its population are within the 10% most deprived in the UK, and 15% of the children within the ward live in poverty (down from 27% in 2010). The area's life expectancy is 73 years for people born male, and 78 for people born female—significantly lower than the national average of around 88 years.

Teacher 1 claimed that the school had particular difficulty in engaging with many of the students' parents, many of whom were unlikely to appear at parents' evenings or other similar school events (for example, only two parents attended a meeting about a class's transition between school Key Stages). Despite this, the school itself is recognised to be of a very high standard, having been awarded an 'Outstanding' rating in their latest Ofsted (the UK's Office for Standards in Education) review. While they don't have access to their own transportation (having to instead hire coaches), School 1 lies within a short driving distance of the park referred to in Section 6.1. It also features its own grounds, including a tarmacked playground, sizable green space and a small wooded area.

As this was a primary school, teachers each teach individual classes across all subjects, including those which are technology-related. While Teacher 1 was not very confident in using digital technology, Teacher 2 was seen as the school's 'whizz-kid' teacher. As they taught a slightly older class of students, Teacher 2 frequently tasked them with doing online research during classroom activities. To this end, the school had within recent years established a partnership with an industry leading technology company, who had supplied the school with a smart classroom display and 20 Android tablets. While these were a shared resource amongst all the school's classes, the older classes were given priority, and Teacher 2's class regularly used them during classroom activities. However, as there were typically fewer tablets than there were children per class (typically ~30), tablets were often shared between pairs of students.

7.1.2. Methodology

During this study, I worked with School 1 for a period of approximately one year. The longer study period was chosen for two main reasons: to mitigate the influence of 'novelty' in the children's engagement with the technology (the hope was that once students had used the application multiple times, more authentic engagement could be observed—rather than simply excitement at the chance to use new technology (Sharples, 2013)) and to see how the teachers' approaches to Activity creation would change as they gained experience with the application over time. To this end, rather than have the research team create Activities for the students to complete, the teachers used the application at their own volition: they took on a co-researcher role, creating the ParkLearn Activities independently and developing their own design ideas. The teachers chose to use the application a total of eleven times (listed in Table 7.1) between the two classes during the study period: twice with the Year 6 class, and nine times with Year 2.

With the exception of the Activity listed in Table 7.1 Row 6—which occurred without my prior knowledge, for reasons detailed below—I was present for each use of the application with the classes, often acting both as a researcher and a makeshift teaching assistant (providing support, both with the running of the technology and providing adult supervision of the students). Field notes were taken during and after interactions with the classes in order to record observations of the teachers' and children's usage of the technology. Semi-structured, audio-recorded interviews were held with the teachers after the school day of each engagement, usually running around 20-30 minutes in length.

Dr Jarusriboonchai joined for the initial meetings with the teachers (detailed in section 7.1.3), as well as the school trip which encompassed Rows 4 and 5 of Table 7.1. During these engagements, she provided technical support with the app and tablets and recorded her own field notes and observations, which were included with the rest of the results for thematic analysis.

7.1.3. Introducing the Application

Prior to the application being used in class, Dr Jarusriboonchai and I sat down with Teacher 1 and Teacher 2 for an hour, giving them a brief overview of the study, the application itself and how we had imagined it could be used. To serve as examples for what the app could be used for, we had created two simple Activities beforehand. The first took the learner on a bug hunt, using primarily camera-related Task Types to find and photograph insects in an outdoor environment. The second Activity aimed to be more creative: it was about various aspects of movie-making, and involved the learner creating materials for their own film (such as recording 'Foley' sound effects, designing a poster, and recording videos of specific shots). While Teacher 2 understood the ParkLearn application very quickly and didn't feel the need to engage with it very much during this session, Teacher 1 took longer to be comfortable due to their lack of confidence around digital technology. However, it was only a few minutes before Teacher 1 also understood the app, and they were enthusiastic about using it independently: after going through the example materials, they created their own short Activity containing a *Location Hunt* and several *Match Photos*, even going outside onto the school grounds to take the target photos and try out their newly created Activity.

We let the teachers decide together how they would like to introduce the students to the app, and they opted to co-create a simple Activity for use in introductory lessons with their respective classes. This first Activity was very exploratory, designed for use in the classrooms to see how easily the children could use the application (Table 7.1, row 2). This Activity

#	*Activity Title*	*Used Task Types*	*Uploads*	*Uploads' Cumulative Contents*	*Notes*
1	'Our School Grounds'	2 Record Audio; 1 Take Photos; 1 Record Video; 1 Photo Match	1	2 audio recordings; 2 photos; 1 video	Only used by Teacher 1 to test the application
2	'Learning to use ParkLearn'	3 Take Photos; 1 Draw on Photo; 1 Record Audio; 1 Record Video	29	91 photos; 29 drawings; 29 audio recordings; 29 videos	Used in the classroom by both teachers to introduce the children to ParkLearn
3	'Trip to X Hall and Gardens'	2 Take Photos; 2 Photo Match; 1 Record Audio; 1 Record Video; 1 Map Marking; 1 Location Hunt	8	43 Photos; 8 audio recordings; 8 videos	Tablets shared in pairs
4	'X Park—Statues and Monuments'	4 Take Photos; 2 Record Audio; 1 Record Video	0	-	Responses weren't uploaded
5	'Exploring X Park's Flower Garden'	5 Photo Match; 2 Take Photos; 1 Record Video	5	46 photos; 5 videos	Some submissions were lost as tablets were re-used prior to upload
6	'X Park—First Visit'	9 Photo Match; 1 Take Photos; 1 Record Video; 1 Record Audio	7	78 photos; 7 videos; 7 audio recordings	Some submissions were lost due to software bug
7	'KS1 Tree Day'	5 Photo Match; 1 Record Audio; 1 Text Entry; 1 Take Photos	15	67 photos; 15 audio recordings	Children asked to enter their names in the Text Entry Task
8	'Zoological Gardens'	6 Take Photos; 1 Record Video; 1 Record Audio	12	173 photos; 12 videos; 12 audio recordings	n/a
9	'Welcome to Class 2'	2 Record Video; 1 Take Photos; 1 Record Audio	4	8 videos; 7 photos; 4 audio recordings	n/a
10	'Year 2 at X Keep'	1 Record Video; 1 Take Photos;	5	5 videos; 13 photos;	One of the responses was from the site's manager
11	'X Zoo 2018'	1 Record Video; 1 Take Photos;	13	10 videos; 98 photos;	n/a

Table 7.1 The Activities created by teachers 1 and 2, and the uploaded responses created by students. Rows 1 and 4-11 were created by Teacher 1, row 3 by Teacher 2, and row 2 by both.

focused mainly on camera-related Task Types (e.g. finding and photographing items in the classroom), as the teachers perceived them to be more immediately understandable interactions and could be easily completed in the classroom environment. In contrast, while they were excited by the functionality of the *Location Hunt* Task Type, the teachers were worried that the app's reporting of the current distance in metres would be too abstract for some of the younger children, and it would have required the introductory session to be held outside. This session was as much for the teachers to get used to using the application as it was for the students—the teachers were able to practice instructing the students on how to open a particular Activity (opting to use the share code, rather than display a QR code), and see how the students' responses could be uploaded and viewed after the session.

The teachers reported that the introductory sessions with the two classes went well, and by the end of them the children largely understood the ParkLearn app. For the Year 6 children, this may have been because they were already extremely comfortable with using tablets and standard Android application interfaces, and so had very few issues understanding the application's design language. However, some of the younger Year 4 children were less able readers, and so struggled to understand even the simple instructions for each Task created by the teacher. To mitigate this, subsequent versions of the ParkLearn app featured the text-to-speech function, which read aloud the Task's instruction at the push of a button available on each Task's card.

7.1.4. Year 6 Activities

The Year 6 class (aged 10-11, we engaged N=16 of the class) used the application on a trip to a site popular with school groups thanks to its historical, natural and scientific features. The site featured an indoor museum and a large outdoor property featuring woodlands and ornamental gardens. As the location was a significant distance away from School 1, the teacher was unable to visit the site to create the Activity in-situ. Instead, Teacher 2 prepared the Activity (Table 7.1, row 3) independently on their own device the night before, designing it using online resources in combination with their prior knowledge of the location. For Task Types which required additional resources, the teacher downloaded them from the Internet rather than collecting them personally (e.g. using photographs downloaded from Google Images for *Photo Match* Tasks). Using the Activity's share code, the teacher asked the students to pre-load it in the classroom while an Internet connection was still available, prior to the class leaving. Students shared the tablets one between two, with 8 tablets being used (the class was split into two groups of 15-16, with only one group using the app).

The Activity's Tasks included: *Take Photos* of the various wooden bridges present; *Photo Match* Tasks of a modern water pump and an iron bridge; a *Record Audio* of the natural sounds of the forest; a *Record Video* of an Archimedes screw rotating; a *Map Marking* Task to plot where the site's powerhouse was; a *Location Hunt* to navigate the children to a mystery location (an old waterwheel); and a final Task which challenged the children to compete and *Take Photos* of the most beautiful flower they could find. Unfortunately, the teacher's *Map Marking* Task didn't work during the trip, due to the Task Type's reliance on Internet connectivity to load Google Maps and the tablets' lack of mobile internet capabilities.

Due to the class entering into an examination period, this was unfortunately the only time that Teacher 2 was available to use ParkLearn during the study.

7.1.5. Year 2 Activities

After the introduction session, the Year 2 class (aged 6-7, N=29) used ParkLearn on three separate school trips, as well as during multiple activities on the school grounds. For the class's first trip to the park, Teacher 1 created two different Activities at home, independently on their own device. The first focused on the historical monuments and memorials in the park, and asked the children to record videos of each other explaining what each monument was dedicated to (Table 7.1, row 4). The second Activity used *Photo Match* Tasks to find and photograph specific flowers in the park, with a final *Take a Photo* Task asking them to choose their favourite (Table 7.1, row 5). These Activities largely focused on camera-based interactions, as Teacher 1 believed that the younger Year 2 children would be able to more easily understand them than the more complicated Task Types. The students didn't find the first Activity very engaging, and the teacher and assistants resorted to telling the children what to say when recording the videos. Unfortunately, many of the children's responses to these Activities were lost: Teacher 1 didn't see much value in the responses to the first Activity, and so didn't upload them. The students engaged more with the second Activity, however much of the data was wiped by students re-using tablets (this early version of the app didn't wipe Activities after finishing, ready for re-use—that feature was added in response to this).

Teacher 1 also used the application on another trip to different local park, where the park ranger had invited their class to make suggestions as to how the park could be improved. Independent of the research team (we only found out after the trip had taken place), the teacher made another Activity which asked the students to take photos of different areas of the park, and make audio recordings which would then be shared with the park ranger (Table 7.1, row 6). Unfortunately, a bug in this version of the app resulted in the loss of several

children's work, meaning that their feedback was sent to the ranger as part of a classroom writing exercise rather than through the ParkLearn platform. As no sharing functionality yet existed, Teacher 1 resorted to sharing their Google account details with the ranger in order to share the children's uploads. In response, I added the ability to share 'magic links' to uploaded responses on the website, which didn't require the recipient to log into the platform (as described in Section 5.3).

The Year 2 class also used the application during School 1's 'Key Stage 1 Tree Day', using it to identify and talk about the trees they could find on the school's ground. Teacher 1 created an Activity which included a variety of Tasks, from *Photo Match* Tasks which asked students to find particular tree types, to a *Record Audio* which asked the children to describe how it felt to be around nature (Table 7.1, row 7), prompting:

> *'Why are trees special? Listen to the sound of the leaves rustling, stand amongst them and look up – how does it make you feel? Share your thoughts with us.'*

By this point Teacher 1 was getting familiar with how the app worked, and had realised that because all of the students' devices were logged into the same account, identifying which child uploaded what response could be difficult. As a solution, the teacher included a *Text Entry* Task into this Activity, and made sure that the children entered their names into it before starting the Activity. Following this, I added the ability for Activity creators to require a name entry field be completed prior to respondents uploading results, the contents of which would be visible on the 'Your Uploads' and 'Responses' pages on the website (as described in Section 5.3).

The teacher also used the application on a class trip to the zoo (Figure 7.1), with a simple Activity consisting of Tasks which asked the children to take photos of animals, categorizing them into different types. The Activity then asked the students to record video clips, asking them to present a fact of their choice that they had discovered during the day and found particularly interesting (Table 7.1, row 8). Upon return to the classroom, as there was some time remaining before the end of the school day, the teacher showed a small number of the students' video clips on the classroom projector.

The class' final use of the app took place at the end of the school year. Teacher 1 created an Activity which asked four children from the class to give advice to the younger Year 1 students about being in Year 2 (Table 7.1, row 9). The Activity asked the children to choose and photograph an area of the classroom, and record a video presentation giving advice about the do's and don'ts. Rather than rely on the application entirely, Teacher 1 asked the

Figure 7.1 Children using ParkLearn to classify zoo animals during a class trip (using Teacher 1's Activity detailed in Table 7.1, row 8)

children to create their presentations and practice with each other using whiteboards and markers, before then recording using the app. The teacher chose these four children either because they would benefit from the practice (due to a lack of confidence or, in the case of 'Child 1', a speech impediment), or because they were especially enthusiastic about using ParkLearn again. Once the children's responses were uploaded, the teacher played their videos to the class on the classroom's projector via the ParkLearn website.

Teacher 1 went on to use the application twice with the new Year 2 class the following academic year, by which time the app had been re-branded to OurPlace. The first time this new class used the app was during a trip to a medieval castle, for which the teacher had prepared a very simple Activity consisting of only two Tasks: a *Take Photos* and a *Record Video* (Table 7.1, row 10). Due to the space limitations of the castle's cramped rooms, the class was split into two groups—one of which were given tablets with OurPlace loaded onto them. Unfortunately, the tablets weren't used much, due to the students having hands-on activities and tours with the castle staff (Teacher 1 didn't want the students to disrupt the tour through being distracted by the tablets). As a result, not many responses were uploaded by the students. Over a year later, however, one of the castle staff found the Activity (it had been tagged as being at the castle, and so was discoverable by location) and recorded his own responses to Teacher 1's two Tasks.

The final Activity created by Teacher 1 was for the new class's trip to the same zoo as the previous year . While the previous Activity for that location was somewhat structured (with multiple goals for *Take Photos* Tasks), the teacher instead decided to make the new Activity as open as possible, simply asking the students to take photos and videos of things which interested them (Table 7.1, row 11). Again, the class was split into two groups, with only one half having access the the OurPlace app. The number of photos uploaded averaged around 8 per student, less than the previous year's Activity, which averaged around 14 photos.

7.1.6. Findings & Observations

This observation and interview and data was collated, and then analysed through inductive thematic analysis. Through triangulation via multiple discussions with Dr Jarusriboonchai, a number of codes were identified and collated to result in the development of three agreed core themes: *Supporting Seamless Learning Practices*; *Engagement and Empowerment Through Ownership*; and *Supporting Civic Engagement and Inquiry*. For the ease of presentation, this section structures the study's findings into these themes, for later discussion in Section 7.1.7.

Supporting Seamless Learning Practices

Children in both age groups were easily able to use the application to independently collect data, allowing them to make the most of being in the field. The application's ability to support children responding through multimedia (images, video, audio) allowed for them to immediately collect data and record their reflections on it, without struggling with poor writing skills and virtual keyboards. This was especially true with the younger children, many of whom weren't strong writers (especially when tasked with writing on virtual keyboards). During a semi-structured interview midway through the study, Teacher 1 revealed that they had purposefully chosen Task Types which wouldn't be technically challenging, allowing children to focus on the Tasks' content rather than struggling with interacting with the technology itself:

> *"It's automatic. They can just speak. [...] When I designed the ['Zoological Gardens'] activity, I basically did the video, because I wanted them not to have to write." - Teacher 1*

Teacher 1 particularly favoured use of the camera, taking up 84% of their created Tasks (Figure 7.2). The first class's interactions with the technology became more purposeful as the study

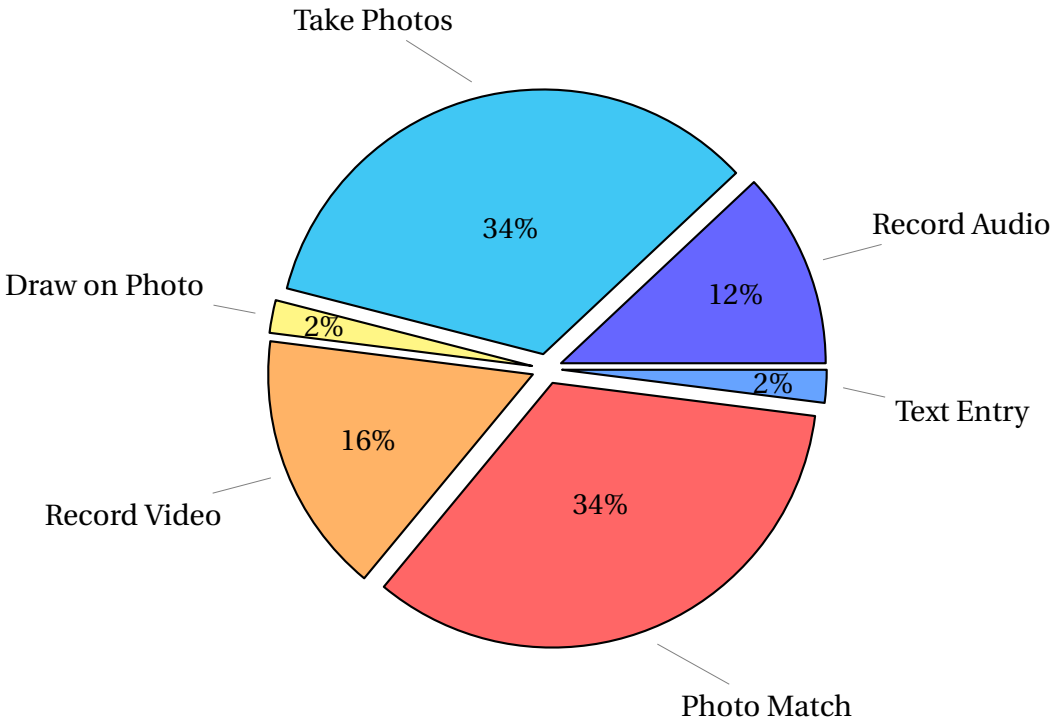

Figure 7.2 Teacher 1's usage of Task Types across their created Activities, including the Activity made alongside Teacher 2.

progressed, unhindered by a lack of familiarity and the earlier versions' bugs. This was shown in the first trip to the zoo: the children were careful to correctly classify each animal into the correct Task, trying to take as good a photograph as possible and deliberately deleting and re-taking any shots that didn't meet their increasingly high standards. One pair of children even decided to re-shoot their video recording twice, in order to ensure their delivery of information was perfect. Despite this perfectionism, each pair still uploaded over 14 photos on average in addition to their audio and video recordings (Table 7.1, row 8). Unfortunately the second Year 2 class didn't have anywhere as much time with the application, with only half of the class having access to the tablets for a whole trip, making it hard to compare. However, the Year 6 children also responded well to their Activity: while disappointed that the *Map Marking* Task wasn't available, they enjoyed competing to take the best flower photo, the *Location Hunt* Task's sound and animation, and competing to take the most accurate *Photo Match*.

The 'Welcome to Class 2' Activity proved to be a very different use-case for the application: in contrast to the other uses of the application, in which it tended to be used as the sole medium for the students' work, most of the learning process took place independent of the technology. Rather than encompass the entirety of the activity workflow, in this case ParkLearn was used to bookend it: delivering instructions and prompts at the beginning to children for talking

points, and at the end of the activity to record their final output for later viewing by the class and evidencing by the teacher. The ability to prepare and redo a video presentation without it being 'live' and in front of an audience proved very effective for children such as Child 1, who Teacher 1 claimed would have normally struggled due to a lack of confidence. Reflecting on the activity after the session, the teacher stated that not only did the children enjoy recording the videos, but that they also took pride in sharing the final results:

> *"[Child 1 would present his work], but he doesn't know what he's going to say, he gets tongue-tied. The pride he'll take in actually being able to give a coherent message and seeing himself back... They far more enjoyed what they were saying and what they were doing." - Teacher 1*

While two of the children didn't want to play back their videos for themselves immediately after recording them, all four participating children were eager to show their videos to the rest of the class afterwards. The other children reacted with excitement at seeing their classmates on the screen, with Child 1 even receiving high-fives. Unfortunately this was the only time during the study that the teachers dedicated significant time to using of the platform's website for follow-up activities in the classroom.

However, Teacher 1 made frequent use of the website for reviewing students' work, seeing great value in how simple the app made creating a structured learning activity, and then collecting the children's responses to it. When interviewed towards the end of the study, Teacher 1 noted that they found that the platform offered an approachable user experience which supported them in producing their own mobile learning activities, despite their lack of confidence with digital technology:

> *"It's powerful, really powerful. The way that packages it up at the end, and how immediate it is, is fantastic for me. I got it straight away, it wasn't a difficult process to do." - Teacher 1*

Prior to the study, the school's teachers had been manually transferring the children's created photos and videos over USB on a weekly basis, uploading the children's media to 'Earwig'—an evidence of learning portfolio suite used by the school. Teacher 1 argued that ParkLearn's smaller output file sizes and upload pipeline was far simpler and better suited to their workflow:

> *"That simplicity takes away a lot of hassle—if I was to take photographs on my [tablet], I've got to get the lead, plug it into my hard drive, transfer the photos across,*

choose where I want to save them... Whereas this packages everything together." - Teacher 1

This one-step system took a fraction of the time compared to the old backup routine, meaning children's creations would be discarded less often. Its simplicity even allowed the teachers to delegate uploading to the children. Teacher 1 also valued that the submissions appeared on the website in the same format as they appeared on the learner's device:

"What I like about the app is you can pull together different ways of collecting and showing information. Simply by pressing that upload button, it puts it onto my screen to save and to use in that format. That's the beauty of it." - Teacher 1

Teacher 1 claimed that it was because the application's support for both open-ended and structured learning activities and non-intrusive workflow that they continued to use it with the next class of students. When asked which school trips would benefit from this data collection, they responded: "*Every trip.*" This was demonstrated by Teacher 1 then proceeding to use the app on two further occasions with the following cohort.

Engagement and Empowerment Through Ownership

Both teachers created Activities which ranged between being highly prescribed (e.g. A *Photo Match* Task, asking students to 'Find a birch tree') and open-ended (e.g. A *Take Photos* Task with 'Find what you think is the most beautiful flower'). The Year 2 class's first Activity proved to be very prescriptive, with the teacher resorting to simply having the children repeat her words on video. While the children enjoyed recording each other with the tablets, they weren't very engaged with the actual educational content (suggesting a high influence of the technology's novelty factor). The children's lack of enthusiasm was evident in the resulting videos, leading Teacher 1 to not bother uploading them. Furthermore, this prescriptive nature resulted in the children having less interest in viewing and sharing each others' outputs. Teacher 1 noted in an interview after the first zoo trip that in the cases where Activities leave the students with little creative control, the children were only really interested in viewing their own work:

"When they come back after visits where we've all done the same, children's enthusiasm is not really there for what others have done. The enthusiasm is, 'Can I see what I've done?'" - Teacher 1

When they *were* engaged in the Activities and given some more creative control, the children took pride in the photos they had taken, and particularly enjoyed showing off their creations to each other and the adults present (both in-situ, as the Activity was being completed, and back in the classroom, when results were visible). In response to finding that the students were interested in viewing each others' work if it was independently and creatively produced, Teacher 1 started planning future activities which would involve the children having their own topics in small groups:

> *"They're given a specific task and they take ownership of it, knowing that other groups are not doing that. [...] When we come back to school and we feedback, there's a great interest in what each other has produced because we're informing everybody." - Teacher 1*

The teacher argued that having the students research and respond to their own topics would lead to the children becoming experts on it amongst their friends, allowing for peer-learning activities. They argued that having the students take ownership of the task and knowledge would be an empowering factor for them, boosted by the ability to teach their peers new knowledge:

> *"You can kind of empower yourself through your knowledge and how you're going to present it, and then go off and do it." - Teacher 1*

Supporting Civic Engagement and Inquiry

As well as for purely education tasks, Teacher 1 used the ParkLearn platform as a tool to facilitate civic participation during the class trip to the second park (Table 7.1, row 6), with students providing feedback and suggestions to the park's ranger through the application. Engagement with the local community (including the children's families) through class activities was something that the school was keen to promote. Unfortunately, community engagement wasn't coming easily, with even the children's families not actively participating. Teacher 1 noted that the school was trying to engage with various cultures that could be found within the local community as learning resources, but had been struggling to get parents on board:

> *"We don't have a lot of parental support, but, where we do, we're looking to make cultural links." - Teacher 1*

After this trip to the park, she had tried to make the parents aware of their children's active citizenship through the school newsletter. The teachers noted that their currently used technology, 'Earwig', was impractical for this due to workflow issues such as slow upload speeds and manual data input. During an interview after this park trip, Teacher 1 claimed that as a result of these limitations the amount of digital content shared with parents by the teaching staff had dramatically reduced:

> *"It takes a very long time to upload a video within Earwig, so we've stopped doing it, really." - Teacher 1*

However, Teacher 1 suggested that the mobile nature of learning technologies such as ParkLearn may be better suited to highlighting the value of place and the children's civic engagements with it—as communities are able to access the children's work in-situ, the work is given greater context:

> *"Our parents might go along and just say, 'There's nothing there', because they don't see the resource. However, there could be something on the app like, 'We're involved in it, so go along and see what your children have done.'" - Teacher 1*

Teacher 1 was particularly enthusiastic about the idea of using mobile learning technologies for civic learning, and sharing evidence of the children's civic engagements with the wider community. For example, they suggested using ParkLearn to highlight class visits to local care homes, recording the children's engagements and the elders' knowledge:

> *"Let's say, Christmas you go to the care home. We can use ParkLearn to record what we did and use that within school, upload it to our website to share it with parents." - Teacher 1*

Taking this idea further, Teacher 1 extended it to conceptualise ParkLearn as a tool to facilitate cross-cultural learning engagements, with the technology acting as a medium for digital, place-based 'pen-pals':

> *"We have a link with a school in India. The app is a perfect way of interacting with them, showing each other." - Teacher 1*

Beyond the civic engagement with the park ranger, Teacher 1 also used the ParkLearn platform as a medium to encourage the students in reflecting upon their experiences in place, and their relationship with space. For example, the 'KS1 Tree Day' Activity asked children to record audio in response to an open-ended prompt. While a large number of the children's responses gave an appreciation about many of the reasons trees were useful (e.g. food, fuel), some of them also included more personal reflections and metaphorical observations: several children talked about how they "loved" the trees, and how it looked like they "dance" when there's a slight breeze.

7.1.7. Study Discussion

These engagements provided several discussion points around how ParkLearn addressed the design goals set out in Section 5.1, as well as several other points which I believe should bear consideration in future designs for seamless mobile learning technologies. This discussion has been separated by the three themes produced through the previously discussed thematic analysis, respective to the relevant data in the previous section. These themes are: *Supporting Seamless Learning Practices*; *Engagement and Empowerment Through Ownership*; and *Supporting Civic Engagement and Inquiry*.

Supporting Seamless Learning Practices

The features and open nature of the application's authorship process and website component means that it arguably supports all ten of Wong and Looi's dimensions of mobile-assisted seamless learning (Wong and Looi, 2011). This includes the four research and design gaps which they identified: use of multiple device types in different contexts (demonstrated with ParkLearn through use of tablets in the outdoors, and the desktop and projector in the classroom), switching between multiple learning tasks (demonstrated by combining Task Types, supporting both the teacher and learner in promoting different interactions and contextual considerations), knowledge synthesis (e.g. how the teacher noted the potential for children to create peer-learning ParkLearn Activities based around their own research, either independently or in groups) and the encompassing of multiple pedagogical or learning activity models (e.g. supporting both individual (or paired) work with tablets in an authentic context and collaborative classroom discussion around the uploaded responses). I argue that ParkLearn fulfilled DG2 ('Support seamless outdoor and classroom use') by incorporating these dimensions of seamless learning, allowing it to be flexible enough for teachers to

incorporate different devices, contexts and pedagogical approaches into their activities as they see fit.

Over the course of the study, the role of the application changed from being the learning objective to becoming a teaching support tool. In the Year 2 class's first Activity, the technology took centre stage and became the learning focus. This overbearing design meant that not only did the children have little agency in their output, but they weren't paying much attention to the learning environment. As discussed in Section 4.6.3, mobile learning design should aim to strike a balance between direct and technology-mediated environmental interactions, if it is to take advantage of that environment as a learning resource. The teacher's later Activity designs sought to strike that balance, preferring the ParkLearn Task Types which focused on the learning environment (demonstrated by their heavy usage of camera-based Task Types). As the children were exposed to the technology fairly regularly over a longer period of time, its novelty gradually diminished—one of our key motivations for having the study taking place over such a long time frame (Sharples, 2013). Arguably, this could also have led to the app providing fewer distractions from the environment. The hundreds of photos, videos and audio recordings created and uploaded by the children during their trips (as shown in Table 7.1), as well as the numerous and varied Activities uploaded by Teacher 1 (who was self-described as being less than confident with digital technologies), suggest that the participants were easily able to use the application to support their creative output. That this occurred in multiple learning contexts across a range of ages (between 6 and 11 years of age) suggests that the platform was successful at implementing DG5 ('Support learning and reflection in authentic learning contexts') and DG4 ('Support a wide range of user ages and technical expertise').

By supporting the offline caching of both teachers' Activities and the children's responses on devices shared between several students, the application also supported structured outdoor activities without the need for constant Internet access or a one-to-one device-student ratio (addressing DG6: 'Support mobile learning in resource-limited schools'). The *Map Marking* Task created by Teacher 2 was the regrettable exception to this. The technology also helped Teacher 1 utilise the children's existing work for new educational activities in the classroom: by using the ParkLearn website on their laptop and classroom smartboard projector, Teacher 1 was able to facilitate full class discussion of students' work uploaded from the tablets through the ParkLearn platform. Presenting the students' responses on the website in a similar format to how they're displayed in the application (complete with the teacher's prompts, images and the app's iconography) had two main advantages: it allowed the teacher to review the children's work in the context in which it was first presented to them, and it also gave the students a familiar reference point to support them in doing related work in a different

environmental context. Land's argument that the use of visual elements can allow users of varying abilities to partake in mobile learning activities (Land et al., 2015) suggests that young children would have struggled with the equivalent text-based, CSV style table interface output by technologies such as WildKnowledge (WildKnowledge, 2015). Through simple interfaces which grounded the learners' contexts (DG5), ParkLearn supported transitioning between devices, learning environments and related activities (DG2).

Despite this, Teacher 1 made little use of the website for follow-up classroom activities with the children, only using it for the 'Welcome to Class 2' deployment, to highlight a few of the videos from the Zoo trip, and to share their uploads for the 'X Park—First Visit' Activity with the park ranger. I postulate that this could be due to the following factors: 1) the school trips in which the application was used often took place at the culmination of a school project, meaning that no further classroom time was to be dedicated to the subject of the Activity; 2) the Activities were often designed primarily as 'experience enhancers' which supported the students in engaging with the learning environment, rather than gathering data which would be useful for further engagements; 3) the trips largely ran until the end of the school day, meaning that often no time was available to upload and view the uploads. Future studies with schools will endeavour to explore the functionality further.

Engagement and Empowerment Through Ownership

Throughout the study, the students, teachers and volunteers valued having ownership of their work. This could be seen in multiple instances such as the first zoo trip, where the children took pride in their creations and showed off them to anyone that would listen. Frequently, the students voluntarily recaptured videos if their narration could be improved, and they deleted and re-shot photographs if the framing wasn't up to their own standards. They would perform multiple takes of video and audio recording if they stumbled over 'lines', even if what they recording wasn't meant to be scripted. As noted by Teacher 1, this pride was evident on return to the classroom, where they were eager to revisit their creations and show them off to their peers.

However, this enthusiasm wasn't always there for viewing other children's responses to the same Activity, particularly when the Tasks within that Activity were very prescriptive, without much room for learner interpretation or creativity. As a result, Teacher 1 believed that ownership of the task was an important contributing factor to the children's enthusiasm. This change of mindset can be seen when comparing the first zoo Activity (Table 7.1, row 8, consisting of: 6 *Take Photos* Tasks, 1 *Record Video*, 1 *Record Audio*) created by Teacher 1

to the second (Table 7.1, row 11, consisting of: 1 *Take Photos*, 1 *Record Video*). The teacher wanted to avoid making the children feel limited in what they could record in the app: as far as Teacher 1 was concerned, if the children are interested in something, it should be captured for later discussion in the classroom. There was a concern that having multiple *Take Photos* Tasks, with each dedicated to a specific topic, potentially precluded the students from capturing everything they wanted to. As a result, Teacher 1's second zoo Activity was extremely free-form, with the ParkLearn platform being used more as a media pipeline than for the purpose of creating structured Activities. However, this didn't seem to lead to a greater level of engagement with the students (8 photos per student, compared to the original Activity's 14). While this could be attributed to multiple other factors (for example, the second class spent more time with a tour guide, and were less familiar with the application), it could also suggest that having a degree of structure within the design of these Activities can be useful. This correlates with Frohberg's findings around the level of *control* granted to students within the Task Model for analysing Mobile Learning: Frohberg argues that foregoing any degree of structure or scaffolding risks over-straining learners, with a lack of oversight potentially leading to disorientation, missed learning goals, frustration or the development of false conclusions (Frohberg et al., 2009).

Beyond this, Teacher 1 also hypothesised plans for future ParkLearn activities which would involve groups all researching different topics. The teacher argued that the groups having this unique knowledge would lead to the children becoming experts on their given subject, with the ownership of the task and knowledge empowering them through the ability to teach their peers. A natural progression of this would be for children to create Activities for each other, moving towards giving the students greater control and supporting deeper reflection through content construction (Frohberg et al., 2009; Heslop et al., 2017). This approach has already seen success in mobile learning technologies such as Mobilogue, where students' ownership of their created quizzes prompted greater engagement (Giemza et al., 2013). That ParkLearn could be utilised to facilitate these different forms of pedagogy while still meeting the teachers' formal requirements (e.g. the need for evidence of learning) suggests that it successfully implements DG3 ('Support a variety of pedagogical approaches and stakeholder requirements').

Supporting Civic Engagement and Inquiry

During this study, ParkLearn acted as a medium which facilitated civic participation, showing an opportunity for mobile learning technologies to act as 'gateways' to active engagement with civic space or communities. This supports the suggestion in Chapter 6 that mobile

learning technologies can engage with spaces' social infrastructures, supporting learners and content creators in harnessing them as resources for civic learning. Teacher 1 argued that an opportunity existed for such technologies to highlight to the students' parents the value of these community resources, and the children's impact upon those resources as active stakeholders. As shown in the example of the hypothesised care home visit, this form of 'highlighting' could also be used to learn about the lives of members within communities who have been ostracised, forgotten or underappreciated. Given the School 1's ongoing struggle to meaningfully engage with the children's families, the surrounding community, and—given the ward's level of poverty—the number of people within it who are likely to be in vulnerable situations, Teacher 1 strongly believed that such efforts were worthwhile.

From a practical perspective, these engagements suggest that through supporting multimedia data collection and sharing through multiple device types, seamless mobile learning technologies can facilitate the sharing of civic knowledge and values with a wider community. While the school's 'Earwig' software had been deemed impractical by the teachers due to the lengthy upload process, ParkLearn's immediacy was seen to be able to support such interactions without disrupting the teachers' workflow. Teacher 1 also noted that beyond simply including the children's parents, this could also be extended to sharing values and practices in cross-cultural learning engagements (DG1, 'Utilize local places and communities as learning resources'). As previous work by Sarangapani has shown, multimedia data collected through mobile devices can be used as effective cross-cultural learning resources (Sarangapani et al., 2016). However, further opportunities clearly exist to explore how mobile learning technologies can support civic inquiry. There exists some precedent for how this might be achieved: when combined with the nQuire-it platform, the Sense-it application supported 'citizen inquiry learning' by acting as a scientific toolkit (Sharples et al., 2017). In a manner similar to this, I propose that mobile technologies could also act as toolkits to support 'civic inquiry learning': fostering cross-cultural communities of inquiry, through the design of creative learning activities to share and enquire about civic values and practices.

7.1.8. Limitations and Going Forward

This study was partially limited by the time limitations placed upon our participating teachers. The application did not see as much usage by the Year 6 class due to a more demanding curriculum (resulting in fewer field trips) and the beginning of their exam season. Coming out of this longitudinal study, we determined that future work in the project would further investigate the app's use with this age group (and older, if possible). More thorough engagements with children of these ages are detailed in Chapter 8.

Additionally, the installation of the 'talking statue' (discussed in Chapter 6) coincided with the end of the school term, meaning that unfortunately the teachers were unable to use it as a learning resource during this study. Accessing local knowledge and resources through technology was something Teacher 1 claimed to have not considered before, but said it was "*something we would use and we would access*" if it was made available. Work covered in Chapter 8 endeavoured to investigate how community resources could be used in formal education contexts.

The use of the technology of these studies may have also been somewhat limited by the original ParkLearn application's branding and imagery: the Year 6 teacher only used the application for the outdoor section of their class's trip, opting to stow the tablets away for their indoor explorations of the museum. Similarly, it took several months for the Year 2 teacher to use the application in an activity which didn't relate to parks, plants or animals. It's possible that the original app's branding inferred a limitation of how it could/should have been used, potentially changing the behaviour of the teachers. The studies discussed in Chapter 8 all took place after the platform was re-branded to OurPlace, meaning that they were able to expand on these findings by investigating its usage in other contexts with context-neutral branding.

7.2. Use of OurPlace in other School-based Research Studies

This section describes the use of OurPlace by in schools in two studies by other researchers, where its use was a tertiary result: that is, OurPlace was being used within these separate projects as an established tool, rather than being the subject of the research. This use of OurPlace as a single component influenced the design of the learning framework described in the next chapter.

Sense Explorers

The OurPlace app was used with a Year 5 class (N=30, ages 9-10) during a separate research project, *Sense Explorers*, led by Sean Peacock. This project worked with schools to give children tools to gather data about environmental problems in their neighbourhood—such as air and noise pollution—and ideate potential solutions to make it a better place. Schools are able to use a toolkit of activities made up of several stages: explore (collect evidence of the current state of the environment, using both human senses and digital technologies), react (gain an understanding of the collected data and its implications), design (create designs,

Figure 7.3 Students using OurPlace to log environmental data readings during the Sense Explorers project.

informed by the findings, which address an identified issue), and influence (share the findings and designs with others).

Several technologies have been used as a part of the design section of the Sense Explorers process. In several implementations, the OurPlace application has been used by students in tandem with a custom Raspberry Pi device. During these activities, students were guided by *Location Hunt* Tasks in a pre-made OurPlace Activity to particular sites of interest, and, through Follow-Up Tasks, asked to take readings from the Raspberry Pi (e.g. air quality, decibel readings). This data could then be logged into the *Text Entry* Follow-Up Tasks, and reflected upon by the students in-situ using the more free-form *Record Audio* and *Record Video* Tasks (Figure 7.3). This use of OurPlace demonstrates how it can be used to utilise local space and place as learning resources (DG1), with the children's learning contextualised within their own local environment. After collection, the children's observations and reflections were then uploaded to the OurPlace site, for use in the later stages of Sense Explorers.

As with Teacher 1's 'Welcome to Class 2' Activity (Table 7.1, row 9), these studies demonstrated that OurPlace can be useful as part of a larger process, and doesn't need to be at the centre of the learner's attention throughout an educational activity to be an effective tool. For example, Teacher 2 used the application to give the students instructions and record their final outcome, while the majority of the students' time was spent discussing the subject and using external tools such as whiteboards. Sense Explorers took this a step further, and

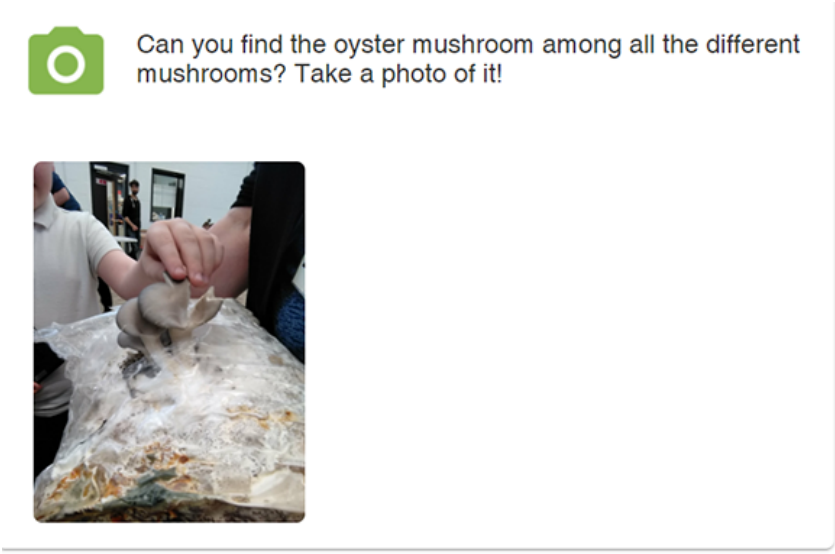

Figure 7.4 A student's uploaded response to a *Take Photos* task, taken during a school trip to a mushroom producer as a part of the Tyne Fresh project.

made OurPlace a single component within a much larger pipeline—the observations and reflections submitted by students via OurPlace went on to inform their later designs. This pointed towards the potential for creative mobile learning technologies such as OurPlace to be useful as tools within project-based learning (PBL) style pedagogies. Our later explorations of a framework for using place-based mobile learning technologies within all stages of PBL (not just research, but also the creation of a final product) are discussed in Chapter 8.

Tyne Fresh Field Trips

As a part of a research project relating to food sustainability and the use participatory design in local food production and consumption (Prost et al., 2019), several researchers at Open Lab have developed the social enterprise 'Tyne Fresh'. Developed in partnership with local food producers and a community hub, Tyne Fresh aims to connect the community with local producers—encouraging the consumption of sustainable and healthy produce—and also supports the local food bank with proportional donations.

One of the researchers, Sebastian Prost, has used the OurPlace multiple times during related engagements with school students. The first of these was using the OurPlace app with school students during a field trip to a local mushroom producer. Prior to the trip, Prost worked with the producer to create an OurPlace Activity for the students to complete in pairs on the day. This Activity used Follow-Up Tasks to structure the children visiting different 'stations' in the

mushroom farm, each concerning a different aspect of food production. Tasks varied from challenging students to find and *Take Photos* of particular types of mushroom (Figure 7.4), to *Record Audio* of their reflections and understanding of the sustainable growing processes taught to them on the trip. This Activity was produced by combining the researcher's experience in digital systems with the community member's expert domain knowledge, resulting in an Activity which made good use of the technology through an assortment of interactive Task Types, but also meaningfully engaged with the subject domain. In this way, OurPlace had been used to utilise the knowledge and values of local community members as a learning resource within a formal education context (DG1).

Prost used the OurPlace application during another school trip to the food bank supported by the Tyne Fresh project. This time, rather than the researcher create the Activity with the domain expert, he co-produced it with the students. Prior to the trip, Prost asked the children to prepare questions which they would like to ask the staff at the food bank, or ascertain from their own investigations during the trip. These questions included: '*Does the food bank have to waste or throw out food?*'; '*Are you handing out more food or less every year?*'; and '*How much fresh food compared to tinned food is there at the food bank?*'. A total of 28 of these questions were then inserted into the app as a mix of *Record Audio*, *Multiple Choice* and *Text Entry* Tasks, with each question also crediting the students who submitted it (further supporting the theme of Activity co-production). When asked about his inclusion of the OurPlace app and its role within the class project prior to the trip, Prost said:

> *'The kids will work in teams and each team member will have different roles. I'm trying to find a balance between hands-on activities (so they need their hands free), non-digital and digital tools.*
>
> *In teams of 6-7, three pupils will be "workers", doing some of the work in a food bank, while the other three document. One of these will be a "journalist" with an iPad to take photos and videos, another will be an "illustrator" with a clipboard, pen & paper to illustrate the process/how a food bank works. And one will be a "quizmaster" and has the OurPlace app.*
>
> *Afterwards they'll use the all the materials to create some paper-based content reflecting on their visit.'*

This continued the trend of using OurPlace as a supporting tool within a larger, PBL-style process, with the app being used during the research and resource gathering stages in preparation for the creation of a final product (in this case, the children's paper-based content which

reflected upon the role of the food bank, food production and consumption within wider society). However, rather than the OurPlace Activity being produced by the students themselves (as explored in Chapter 8), this was instead co-created by the children and researcher.

7.3. Summary

This chapter covered the use of ParkLearn and OurPlace within formal education contexts, where teachers and researchers had created Activities for students to complete. These studies aimed to assess the application's success as a design for civic mobile learning, and also investigate new ways in which such technologies could be used.

Through these studies, the platform was demonstrated to meet its design goals noted in Chapter 5: it was shown to be able to utilise place and communities as learning formal education resources through the Sense Explorers and Tyne Fresh projects; the platform was used by teachers seamlessly across multiple contexts, such as the classroom, school grounds and external locations; it shown to be flexible enough to support a variety of pedagogical approaches (with Activity design decisions being able to afford students very little or very large amounts of control over their learning); both adults and children as young as 4 years old were shown to be able to use the application, and it was used by participants who boasted little in the way of technical confidence; the application supported students in situated learning and reflection in authentic contexts, with the added ability to bring those observations and reflections back to the classroom for later use; and its design was iterated upon throughout the studies to provide greater support for device sharing and offline usage by schools with limited resources.

Teacher 1 noted that the simplified processes and interfaces offered by the application meant that they could once again fit the uploading of children's work into their workflow, allowing them to promote follow-up classroom activities and even share the children's content in engagements between the school and the surrounding community. Furthermore, through supporting the creativity and independence of students, Teacher 1 argued that the platform promoted their ownership of content, increasing learners' engagement in follow-up classroom activities. Through a combination of these two factors, Teacher 1 also helped us identify opportunities for mobile learning technologies such as OurPlace to support cross-cultural civic inquiry, encouraging learners to share their values, knowledge and questions in a manner already embraced by citizen science research.

As the platform matured and the studies went on, OurPlace also started being used as a single component within larger processes. For example, Teacher 1 used the application to give

the students instructions and record their final outcome, while the majority of the students' time was spent using external tools such as whiteboards. The Sense Explorers and Tyne Fresh projects took this a step further, with OurPlace being used as a research and resource gathering tool in preparation for the subsequent creation of a final product. These uses of the platform all pointed towards the potential for creative mobile learning technologies such as OurPlace to be useful as tools within project-based learning style pedagogies—an application which will be explored in Chapter 8.

Chapter 8. Structuring Project-Based Mobile Learning in Place

While through these explorations we had already seen that OurPlace was successful in addressing its design goals in place-based community knowledge and value sharing (as discussed in Chapter 6) and adult-led Activities for seamless mobile learning in formal education contexts (as discussed in Chapter 7), these studies had presented a third context to explore: the use of mobile learning platforms to support project-based learning pedagogies, where students take the role of Activity designer and the application is used as a component within a larger project. The research covered by this chapter aims to explore how mobile learning technologies such as OurPlace can be effectively utilised within project-based learning processes in schools, particularly in students producing their own interactive learning resources. This chapter explores the concept of 'project-based mobile learning' (PBML) through the creation of a PBML framework, and contributes insights from its application and iterative development in the following studies:

Study	***Engagements***	***Purpose***
Schools 2 & 3	Deployments in and out of classroom, semi-structured Teacher interviews	Assess and iterate on the initial PBML framework design in two different socio-economic school contexts
Schools 4 & 5	Extended engagements and deployments in and out of classroom, semi-structured Teacher interviews	Assess amendments to PBML framework in two different age groups and socio-economic school contexts
Travelling Showmen	Class engagements in school 5, teacher interviews, technology deployments in Showmen community	Investigate effects of adapting PBML framework for shorter time spans, its use in cross-cultural civic-learning contexts

This chapter provides suggestions for the PBML framework's configuration in response to contextual challenges, reflections on how PBML harnessed students' existing desires for independence, and how it could offer new avenues for leveraging place as a learning resource.

The chapter concludes by arguing for further exploration of how mobile technologies can support the creation and sharing of interactive content within project-based learning.

Much of the work covered by this chapter was peer-reviewed and published at CHI 2020 (Richardson and Kharrufa, 2020), with the paper being co-authored by Doctor Ahmed Kharrufa.

8.1. Why Investigate Project-Based Mobile Learning?

As discussed in Section 3.3, project-based learning (PBL) is an approach to teaching and learning which focuses on engaging students through the investigation of non-trivial, 'authentic' problems in a manner which supports learner autonomy over the course of an extended project (Blumenfeld et al., 1991). These projects frequently involve the creation of public artefacts (shareable and critiquable externalizations of students' cognitive work), employing constructionist learning processes (Holubova, 2008; Papert and Harel, 1991). However, despite the reported advantages of PBL-style pedagogies, the restrictions placed upon teachers (be those constraints of time and money, or top-down restraints imposed through the setting of targets and the perceived need to 'teach to the test') frequently impacts their available teaching time, curriculum content and pedagogical approaches. This has meant that for many schools in the UK, implementing project-based learning activities into regular class curricula has proven to be a challenge (The Education Endowment Foundation, 2018).

At the same time, mobile learning has grown to play a large role within schools in the UK in recent years: access to tablet computers has become much more common in schools (44% of UK schools are expected to have one tablet per child by 2020 (British Educational Suppliers Association, 2015)), and their general ubiquity has meant that most of the younger population is familiar with the use of mobile technologies (84% of UK children aged between 8–16 report owning a smartphone (Statistica, 2018)). As an example, the school that we worked with extensively in Chapter 7 regularly used tablet devices, as tools to be used both within the classroom and for capturing data (usually photographs) on school trips.

However, as a result of the lack of uptake of PBL within UK schools the growing ubiquity of mobile devices hasn't fully been taken advantage of, and the potential of these devices as tools within PBL activities is going unfulfilled. Furthermore, due to the lack of HCI research around how mobile learning technologies can be used for artefact creation throughout the PBL process (Chan et al., 2015), the possible roles they can play as tools within PBL is still under-explored.

Demonstrating the Medium	*Researching the Domain*	*Prototyping*	*Creating & Refining*	*Sharing in the Wild*

Table 8.1 The steps of the PBML Framework, to be completed in order.

Element	*Description*
'A Challenging Problem or Question'	The project is framed by a meaningful problem to be solved or a question to answer, at the appropriate level of challenge
'Sustained Inquiry'	Students engage in a rigorous, extended process of posing questions, finding resources, and applying information.
'Authenticity'	The project involves real-world context, tasks and tools, quality standards, or impact, or the project speaks to personal concerns, interests, and issues in the students' lives.
'Student Voice & Choice'	Students make some decisions about the project, including how they work and what they create.
'Reflection'	Students and teachers reflect on the learning, the effectiveness of their inquiry and project activities, the quality of student work, and obstacles that arise and strategies for overcoming them.
'Critique & Revision'	Students give, receive, and apply feedback to improve their process and products.
'Public Product'	Students make their project work public by explaining, displaying and/or presenting it to audiences beyond the classroom.

Table 8.2 PBLWorks' seven essential project design elements of project-based learning (Larmer and Mergendoller, 2019)

8.2. Overview of the Project-Based Mobile Learning Framework

For these studies, I wished to explore the potential for mobile learning applications such as OurPlace to be used as constructionist tools within a PBL process, used by students to create new learning resources for use by their peers. To this end, I designed a PBML framework for practical use by teachers working within schools. Both my anecdotal experience and previous literature (Blumenfeld et al., 1991; Innovation Unit, 2016; Krajcik and Blumenfeld, 2006; The Education Endowment Foundation, 2018) would suggest that this framework would need to be able to adapt to variations in teachers' time, teaching requirements and levels of mobile hardware access. In response, I designed an adaptable five-stage framework (Table 8.1) designed to work alongside the seven essential elements of PBL (Table 8.2). This framework asks students to create a mobile-learning artefact as a final public product, following a series of PBL engagements in response to their teacher's chosen '*Challenging Problem or Question*'.

As with the development of the OurPlace platform itself, this project was undertaken through a design-based research approach: one in which researchers work alongside practitioners (i.e. teachers) in naturalistic settings, and produce multiple iterations of designed interventions to explore theoretical relationships (Barab and Squire, 2004). As such, the final framework

design was created iteratively in response to the findings covered later in the chapter. The stages of this final design, and how they were applied them using OurPlace, are described below.

8.2.1. Demonstrating the Medium

Following the instructor introducing the students to the '*Challenging Problem or Question*', the students should be introduced to the technology they will be using to create the final '*Public Product*'. This stage gives students a hands-on example of an exemplar application of the technology, allowing them to become familiar with its potential and encouraging them to bear the technology's capabilities in mind when formulating ideas during the following stages. We found that ideally this should take place in an easily controlled environment, such as in the classroom or on the school grounds, and that demonstrating the place-based technologies on the school grounds is particularly advantageous: it allows students to explore the technology's functionality in a safe outdoor environment, and doesn't require the overhead of additional teaching assistants who would likely be necessary on trips to external locations.

For OurPlace, students should be introduced to the structure of an Activity and be given some examples of how the different Task Types can be implemented. This could be performed with an example Activity (as the teachers at School 1 did, described in Section 7.1.3), created to demonstrate all of the different Task Types available. Given that some of OurPlace's most popular functionality is tied to GPS connectivity, doing this outside is preferred whenever possible.

This would likely be similar with other technologies, unless they are simple enough to be self-explanatory and thus not require demonstration. As it is only focused on introducing the potential of new technologies and doesn't involve the students creating or researching anything towards the rest of the project, this stage can be skipped on subsequent projects using the same combination of technology and students.

8.2.2. Researching the Domain

Given the importance of '*Sustained Inquiry*' to PBL, this framework allots a significant amount of time to students investigating the given problem domain. This is likely to be assisted in some way by technology, however other options exist such as fieldwork (e.g. site visits, performing interviews) and offline research (e.g. in libraries). In terms of technology use, this could take place in the classroom through the use of laptops or desktops to perform research

online, in-situ using mobile devices (e.g. using Zydeco to structure data collection during site visits, or while performing interviews (Kuhn et al., 2011)), or using seamless learning technologies in multiple contexts. A degree of autonomy should be granted to the students, however some guidance from a teacher may be required: this could take the form of 'nudges', such as an initial research topic or a more structured plan of action.

OurPlace could be used in this stage in two ways, either: 1) with students completing Activities which have been created by other people (e.g. community experts, or the teacher) concerned with the subject they are researching; or 2) using OurPlace as a seamless data collection tool, and using it to gather resources (e.g. photos, video, audio), observations and reflections in-situ for later use in the classroom.

8.2.3. Prototyping

In this stage, students create a low fidelity (e.g. pen and paper) prototype of their public entity, using their research as its content. Our reasoning for having students create a low-fidelity version outside of the technology is that doing so: (i) doesn't require access to mobile hardware, minimising the monopolisation of devices by individual classes in resource-limited schools; (ii) lets students design without having to simultaneously learn the technology's authoring interface, which might present its own learning curve and challenges; (iii) emphasises the learning focus as being on the content, rather than the technology (Bell, 2010) and any remaining novelty surrounding it; and (iv) supports visual learning and tangible interactions, supporting children with different learning requirements and making it easier to support group-based collaboration between students (Stanton et al., 2001). The speed of development of low fidelity prototypes also aid iteration and '*Critique & Revision*'. Example prototypes might consist of storyboard or map-based activities—for example, in the study by Sarangapani et al., students were able to plan out and prototype their videos by producing visual storyboards prior to recording them (Sarangapani et al., 2016).

To prototype OurPlace Activities, we modified the jigsaw workshop activity first used with the teachers and park rangers in Section 4.2.4. This jigsaw exercise (Figure 8.1) allowed students to design different configurations of their Activities, prior to engaging with the app's authoring interface (Figure 8.3). The jigsaw's structure is directly analogous to that of an Activity: a single piece is dedicated to the Activity's title, description and cover image, with its Tasks represented as separate pieces connecting to this first piece, and chaining together. Each Task's jigsaw piece has a slot for a smaller Task Type piece, and the jigsaw allows for Task pieces to be connected in different directions to indicate Follow-Up Tasks. Pieces feature a

layer of sticky-back plastic and are written on with dry-wipe pens, allowing the students to make amendments and the jigsaws to be reused (addressing the teachers' hesitation about engaging with single-use teaching materials, highlighted in Section 4.2.4). As this is easily rubbed off, we photographed students' finished prototypes—both for data collection, and also for the students' own reference when creating their Activities in the OurPlace app during later sessions.

8.2.4. Creating & Refining

Further underscoring the importance of '*Critique & Revision*', this stage involves the creation, testing and iteration of the public product, this time using the mobile technology. Depending on the technology and how detailed students' prototypes are, this could simply serve as a digitisation process. This product could either be created through an existing mobile technology (e.g. recording and editing video), or could itself be a new technology (e.g. creating a mobile app through AppMovement (Garbett et al., 2016)). Once completed, students may want to garner feedback, refining the artefacts in response to any issues encountered by themselves or their peers.

For OurPlace, this stage involves creating Activities within the mobile application. As the jigsaw prototype very closely mimics the structure of a final OurPlace Activity, this stage can particularly benefit from having a prototype as a reference point (evidenced in A.3.4). However, students may still require guidance from the educator/researcher as to the intricacies of how the creation process works.

8.2.5. Sharing in the Wild

The students' final created products should ideally be shared with peers or the wider community (making them '*Public Products*' which can undergo further '*Critique & Revision*'), as previous research has shown it can encourage students to engage more deeply in the creation stages by supporting critical thinking (Heslop et al., 2017; Sarangapani et al., 2018). Sharing "in the wild" lends further '*Authenticity*' to this stage, giving students the opportunity to demonstrate and '*Reflect*' upon their knowledge and progress within an authentic learning environment.

For OurPlace, students can exchange their uploaded OurPlace Activities with their peers, and experience each other's creations by going out into that authentic learning environment. Alternatively, they could share their Activities with their families, the local communities

Figure 8.1 A student's jigsaw prototype of an OurPlace Activity. The Activity's details are at the top, with Tasks and Follow-Up Tasks adjoining.

outside of the school, or even through remote partnerships as Teacher 1 had previously suggested. OurPlace is slightly different to many other technologies during this sharing stage, as it goes beyond the traditional process of sharing a final, immutable product: the products themselves are interactive learning activities, the completion of which can result in further creative responses or educational resources from those who use them.

While OurPlace has its own sharing pipeline through share codes, QR codes and location tagging, other technologies could also be utilised to assist in sharing artefacts with other students or the wider community. For example, the Science Everywhere platform could be used to show and invite interaction with students' artefacts on public displays in community areas—potentially supporting the sharing of the students' public products in authentic place (Ahn et al., 2018).

8.3. Studies

I needed to assess how well this framework would work when applied within a real school context, how it could be improved, and how it could be configured to adapt to a given school's time and resource limitations. This section discusses studies held with four different formal education schools in the North East of England, as well as engagements held with a summer school of Travelling Showmen. As each of these have their own socio-economic and cultural backgrounds alongside a unique locality, these contexts will be covered individually.

8.3.1. Research Methods & Data Collection

While the previous ParkLearn and OurPlace studies had been somewhat varied in their research approaches (due to their much more open objectives relating to the exploration of the potential roles and benefits mobile learning technologies can offer stakeholders), this series of studies was much more focused, while still following a design-based research (DBR) approach: I wanted to better understand the performance of the PBML framework, how it could be improved, and the roles technologies such as OurPlace could play in the process. As such, while these studies were still exploratory they were much more structured and regular, with all of the engagements with students relating to at least one of the stages of the PBML framework. In-keeping with expected DBR practice, the framework was applied in multiple contexts and with several sets of participants: allowing me to test and generate theory in naturalistic environments, include a greater number of participants' expertise, and provide flexible design revisions in response to findings.

Rather than leave the use of the application up to the teachers in each context, I looked to them for the subject and content of each project: the participant teachers were informed that I was investigating how to structure the use of mobile technologies and local community resources within school PBL activities, and asked if they had topics that could be suitable. Once this had been organised, parental consent was acquired prior to any engagements with the students, with additional consent requested for taking photographs. With the teachers' assistance, I then led a series of engagements with each class, following the structure of the PBML framework.

For simplicity and consistency, the OurPlace app was used as the main technology in each of these projects. All of the students' interactions with OurPlace took place through Android tablets provided by the research team. As we had encountered issues relating to firewalls preventing the application communicating successfully with the OurPlace API during previous school engagements, we circumvented the need to connect to the schools' WiFi networks by providing Internet connectivity by supplying a wireless router and 4G SIM card. Along with the tablets, this router was taken to and from the schools for each engagement.

A mix of semi-structured and unstructured interviews were held with the teachers after each engagement, with the aim of understanding how the sessions compare to their previous experiences with the students and project-based learning activities. These interviews asked the teachers to reflect on the sessions, and if they had any ideas or suggestions for the framework's further development.

Most of the engagements—including the classroom activities, school trips (with the exception of School 2's trip), and teacher interviews—were audio recorded, resulting in an approximate total of 13 hours of audio. The students produced 35 jigsaw prototypes between them, which were photographed after completion (both for the purposes of data collection, and so that the students could refer back to them in later stages of the framework, without fear of the dry-wipe writing being rubbed off). The students' 92 final OurPlace creations were uploaded to the platform, both for sharing with the peers and/or the local community, and also for later analysis. Oral feedback was given by students during the engagements, with some classes also giving written feedback (noted below, on a per-study basis).

To allow for the design to be responsively updated over the course of the project, the collected data was analysed after the conclusion of each study. This involved reviewing the recorded audio, and transcribing any clear speech—the outdoor recordings were often unclear, due to background noise and wind. The different sources of data (audio, photos, OurPlace data) were collated per engagement for inductive thematic analysis with exploratory coding. Unfortunately no other researchers were available for triangulation during these stages. The

PBML framework was then tweaked in response to the findings of the analysis, in readiness for testing in the next study. Most notably, this resulted in the introduction of the *Prototyping* stage, after I found that the students in School 3 (introduced below) were concentrating more on the technology's novelty than the learning content.

At the end of the project, the codes collected from my analysis throughout the process were collated for a final thematic analysis. I categorized these into three themes: *Configuration and Compromise*, *Harnessing Students' Desire for Independence*, and *Leveraging Place through PBML*. These themes were discussed and agreed upon with Dr Kharrufa as a part of the writing process for this work's initial publication (Richardson and Kharrufa, 2020), and are presented for discussion later in this chapter. For brevity, the anonymised findings reported in this section pertain to them.

8.3.2. Configuration 1: Without Prototyping

Our first engagements in this series of studies immediately followed the previously discussed studies (such as *Sense Explorers* discussed in Section 7.2), during which the platform was used as a single tool to support a larger process. Having examined these uses of the app (noting the *demonstration* of the app by Teachers 1 and 2, the use of it for *research* and data collection in Sense Explorers and Tyne Fresh, and the *sharing* of the students' final work output in Sense Explorers), we created an early version of the PBML framework. While similar, this early version was shorter than the final one described above, as it existed without the Prototyping stage. Wishing to iterate and improve on the framework (and explore the potential roles of mobile learning within PBL in general), we began short studies with Schools 2 and 3.

School 2: Context

The first engagement in the PBML studies were with a Year 7 class (age 11-12, N=30) in a secondary school (School 2), located one of the more deprived wards of the North East of England—around 44% of children in the area are classed as living after poverty (after housing costs), and the life expectancy for the area's population is approximately 4 years lower than the rest of the UK. School 2 has been classed as 'Inadequate' in the most recent report by the UK's Office for Standards in Education (Ofsted).

The school's Industrial Alignment Manager (IAM) contacted me, enquiring about the potential to use the OurPlace app during a school project in collaboration with a regional Local Enterprise Partnership (LEP). LEPs are voluntary partnerships between local authorities and

businesses, aiming to identify economic priorities in each locale in order to promote growth and job creation. Alongside IAM and a local bus company, this LEP had helped coordinate plans for a project titled 'Journey through Tyne', which aimed to have students explore how the local community and transport systems have changed over the prior half-century. Through an additional further collaboration with a national charity for older people, a bus journey was planned which would take the students and some elderly community volunteers from their school, through Newcastle's city centre, and then on to the bus company's depot. The project's aim was to promote communication across generations, and to also promote the use of public transport by students living in deprived areas (whose families had poor social mobility, and very rarely travelled outside of their immediate communities). In a follow-up interview, IAM noted that the aim was for this to be mutually beneficial for both the students and the elderly community stakeholders:

> *"These are specific people who live in the community, who have issues around loneliness, want to do more with schools but also may have barriers to working with younger people. [The charity] are also interested in accessibility, and [the bus company] are interested in how they need to adapt to support people." - School 2 IAM*

This project would be undertaken as part of the class's 'Personal, Social and Health Education' (PSHE) lessons, the curriculum for which tends to be more exploratory and holistic than many of the other more fact-based and quantitatively assessed subjects which make up the National Curriculum. As IAM noted during the follow-up interview, this was a good fit for the project:

> *"The PSHE curriculum is slightly different to normal subjects—it's a bit broader, but has a real focus on careers, helping students understand differences... So that's where we're bringing in working with the community, working with older people. Breaking down the barriers, getting [the students] to develop their listening and speaking skills with different types of people, as well as helping students to use different technologies to communicate and help their learning. Everything that we did in the project related back to the PSHE curriculum.' - School 2 IAM*

IAM was interested in having the students use OurPlace during the bus journey, creating Activities to collect data such as photos along the route and interview responses from the elders. This collected data would then be used by the students back in school, in the preparation

and delivery of presentations to the volunteers and representatives from the bus company. During the initial planning meeting, IAM framed the use of OurPlace as a tool to not only collect data for later presentation, but also to promote conversation between the students and the other stakeholders:

> *"At the end, the aim is for students to be able to present back what they've learned, and what they've got back from the project. In order to, as they go into different year groups, be more confident in and outside of school—because a big issue that we find is that the students find it difficult to be able to express themselves, whether that's writing or speaking to people. So we're looking at different forms to be able to develop that, such as using technology as a way of speaking to people to start conversations, and having the opportunities to meet with different people." - School 2 IAM*

School 2: PBML Engagements

Demonstrating the Medium	***Researching the Domain***	*Prototyping*	***Creating & Refining***	***Sharing in the Wild***

'Journey through Tyne' existed as a larger project, in which OurPlace was simply a component for the students to use as a data collection tool. A significant amount of classroom time had been dedicated to the project before the students were introduced to the app, with the students researching how the area and transportation systems within it had changed over time. This research included a session during which the students were introduced to the bus company's representatives (two bus drivers: one male, one female) and could ask them preliminary questions about the company and their work.

As such a large amount of classroom time had been dedicated to the research stage, only one lesson's worth of time (approx. 50 minutes) could be spent introducing the children to the OurPlace app and have them create Activities for the trip. In an attempt to fit into this tight schedule, I decided to cut the '*Demonstrating the Medium*' stage, meaning that the children's first interaction with OurPlace was the Activity creation process.

To give the class some context about how OurPlace Activities worked, I gave a short presentation which described each Task Type and printed handouts of short step-by-step guide to creating them. The students were given this handout and a tablet in pairs to work on together. By the time the teacher had taken attendance, I had introduced myself, and I had explained the OurPlace app, the students only had around 30 minutes to make their Activities. The

class's teacher took an extremely cautious approach to the session, making sure that all pairs had finished each stage (e.g. entering the Activity's title and description) before allowing them to continue.

The class trip took place the following week. Rather than restrict the students to only having access to their own Activity, I pre-loaded each tablet with all of the class' creations, meaning that students could complete each other's Activities. In the two lessons following the trip, the students were asked to use their collected data and acquired knowledge to produce group presentations about the evolution of the area and its public transport. I was invited to attend the presentations, along with the bus drivers and the volunteer elders.

School 2: Results

During the Activity creation, several of the students were visibly frustrated by the teacher's cautious pace, as they were seemingly being more comfortable with digital technology: most pairs eventually continued at their own pace, ignoring the teacher's progress. While each pair (N=15) created some level of Activity, most were very bare-bones, likely due to the short amount of development time. Most created Activities only contained two or three Tasks, with a few only having one. Most were made up of *Take Photos*, *Draw a Picture* and *Record Audio* Tasks, intended to capture the sights along the route and the elders' interview responses, respectively. Only two of these *Record Audio* Tasks detailed specific questions to ask the elders (e.g. '*Do you use the Tyne Bridge more than you used to? If so, why?*'), with most instead having instructions such as '*Ask a question to the elders*'. Despite the lack of detail in the Activities, IAM noted the children's high level of engagement in an interview after the session:

> *"I think it went well, the kids were really excitable. It would have been nice to have more time, maybe work in groups. Because they know that they're doing something in their class that is different, and they're looking forward to the trip, I think a lot of students are getting a lot from it. I could see from today that some of the students who wouldn't usually talk a lot or would step back a bit, came out of their shell today—usually very shy, very quiet, but engaged with this. One of these students said that he uses apps, likes using apps, so that's linking his learning to what he enjoys. A lot of the students struggle with writing, so a lesson that's different, they can find that easier." - School 2 IAM*

Unsurprisingly, the children were excited about the change of learning context during the school trip. While most engaged with the drawing and camera-based Tasks in several Ac-

Figure 8.2 Display boards, assembled by IAM to highlight the research, Activities and results produced by the class. These boards were on display during the students' presentations.

tivities, relatively few meaningfully engaged with the elders on the bus—getting children to record a conversation with the volunteers took some coercion by IAM, who was also present on the bus. The class returned the tablets upon arrival at the bus depot, as the teacher was worried they would distract the children while the tour guide was talking.

The students' follow-up presentations took several forms: some groups produced PowerPoint presentations which utilised photos taken in OurPlace, some used physical sheets of A2 paper, and one group recorded a video. IAM had assembled some of the output created by the class as a result of the project, and displayed them in the presentation room (Figure 8.2). At the end of the presentations, a number of individual students who had shown high levels of effort and understanding were awarded certificates by the stakeholders.

IAM noted in the follow-up interview that having external collaborations was highly valued by the school, as the stringency of the curriculum meant that they would usually struggle to do these kind of community interactions:

> *"With the curriculum it's sometimes difficult to do a lot of engagement with external partners or do a lot of projects. What we've done is look at the curriculum, and see how we can enhance it by working with external partners." - School 2 IAM*

School 3: Context

The next engagement in the PBML studies was with a Year 8 history class (age 12-13, N=32) in a secondary school (School 3) based in a moderately affluent village (for comparison to School 2, the child poverty figure School 3's ward is 17.9%, which is below England's national average). School 3's most recent Ofsted report classed it as 'Good'. We already had an 'in' with the school's leadership team, as a colleague had been in contact with them to arrange studies for another research project. Through this colleague, I approached the school's leadership about the possibility of them doing a PBML project: the school's headteacher agreed, and assigned the class's history teacher (Teacher 3, T3) to the study.

This top-down approach was a different method of engaging with teachers than I had used in prior ParkLearn/OurPlace studies: initial engagements had been previously made with teachers directly, meaning that the ones who opted to get involved tended to be quite enthusiastic about the project (Teacher 1 was a prime example). From the perspective of Teacher 3, this research was something they had been directed to do by their employer, on top of their existing workload. This was something that I was keenly aware of, and made it a goal to minimise the amount of extra work the project would cause for T3, as well as the amount of interference it would have with the class's normal studies. As with many other secondary school teachers in the UK, T3 was under pressure to prepare the students for frequent formal assessments, and so was reluctant to dedicate much teaching time to the project. When we were organising the study over email, they noted:

> *'Workload and time would be the main issues—the commitment it would take up in lesson time. It would be difficult to slot something additional like this in around key assessment work, and also keeping it relevant to the curriculum we are following.' - Teacher 3*

As a result, the project was given a very short amount of classroom time—only two one-hour sessions, with further work to be done by students outside of school. Prior observations of two of T3's lessons with other classes suggested that T3 preferred an 'authority' or lecture style of teaching, delivering information to the class with little control given to the learners (as discussed in Section 3.2.1). School 3 seemed particularly focused on preparing students for examinations, which tended to take the form of a more 'rote' learning style. This usually involves students studying to remember specific details in readiness for regurgitation during an exam—something that the lecture format is well suited for. In-keeping with this style of teaching, T3 appeared ambivalent towards PBL approaches: when queried on their opinion of them, T3 noted '*It's not the way we do things here*'.

School 3: PBML Engagements

Demonstrating the Medium	***Researching the Domain***	*Prototyping*	***Creating & Refining***	*Sharing in the Wild*

Teacher 3 already possessed a paper-based history trail of the local village, designed for use by younger students joining the school. For the study, T3 tasked the class to use OurPlace to create alternative digital trails in pairs, featuring historical elements of their choosing. Prior to our first session with the students, T3 provided the class with a lengthy PDF document and a PowerPoint presentation, which detailed most of the historical buildings in the village. This would serve as a starting point for researching content. Prior to the first session, T3 expected that the students should be fairly well prepared in terms of trail content, noting over email:

> *'The students should already have ideas of what they want to do, but are waiting to see what the software will do. The issue is what the software can do and whether it can be easily tied in with the plans they have made already.' - Teacher 3*

As such, the 'Researching the Domain' stage took place earlier in the process than planned. T3 was also concerned about the students' work being able to function outside of a mobile learning context, hoping to also have 'analogue' versions of the students' trails:

> *'Could a finished product be adapted to be used at another time even if no iPads were available—maybe some of the ideas usable in a non-digital way?' - Teacher 3*

To this end, Teacher 3 encouraged the students to try and design their digital trails such that they would be adaptable to a pen and paper format. As such, the students were told not to rely too heavily on interactions which could not be emulated by analogue means.

Teacher 3 decided to make the majority of the Activity creation process a homework task, with students using their own devices outside of school. This was mainly in response to the extremely limited amount of classroom teaching time that could be dedicated to the project: because we also wanted to go through the students' final Activities, that only left a single hour-long session to work with the students in class. Rather than rush the creation process—as we had done in School 2—it was decided that we would give the students a good grounding with the technology, so that they could then make the Activities outside of classroom time.

In order to prepare the students for this independent work, our first hour-long session was spent *Demonstrating the Medium*. Inspired by the teachers of School 1, I created an example Activity which demonstrated all of the Task Types and several instances of Follow-Up Tasks. These Tasks were custom-made for the school, with *Location Hunt* tasking the students to find particular landmarks on the school's grounds. Using the tablets in pairs, the students then completed the Activity, transitioning from some of the early Tasks in the classroom, to trying out the GPS-related Task Types outside. Upon returning to the classroom, the rest of the session (around 20 minutes) was spent introducing the students to OurPlace's Activity creation tools.

I returned to the school to attend the second hour-long session three weeks later. During the lesson, T3 and I went through the class, sitting with the students and discussing their Activities with them. Due to having only two sessions with the teaching time limitations, the Activities were not shared between students or used outside of the classroom in an official capacity. As a result, only the *Researching the Domain* and *Creating & Refining* were completed by the students during this short study.

School 3: Results

The *Demonstrating the Medium* session seemed to be successful: by the end of the hour, all students reported that they understood the app, what it could do, and how to make their own Activity. Giving the students the opportunity to try out OurPlace's different Task Types on the school grounds appeared to be a good way of introducing the potential capabilities of the technology.

However, Teacher 3 and I both agreed that the students' Activities were underwhelming. While most of the pairs had produced an Activity, they tended to be quite short (averaging 4 Tasks per Activity) and shallow: most served more as explorations of the different interactions possible with OurPlace than a meaningful engagement with the subject matter. For example, one student's Activity asked the learner to simply find and photograph an 'area of interest'.

Despite this, many of the students had engaged strongly with the process and had taken ownership over their Activities: for example, one student's trail featured characters they had created for their personal YouTube channel. However, as a result of the focus on technology interactions, many students struggled in fulfilling the teacher's requirement of creating a paper-based version of their Activity. One pair of students had more success, claiming:

"I think we've found it easier than other groups because we focused more on the content than using all of the different interactions. So a lot of the content can be the same, it's just changing how to interact with it." - School 3 Student 1

Teacher 3 had also noticed the students' focus on interactions with the technology over engaging more deeply with the historical content. In the follow-up interview, they noted:

"The thing I was coming across again and again was the lack of challenge, the lack of depth, and the kind of things they were asking was really just playing with the technology rather than [engaging with the history]." - Teacher 3

This surprised T3, as they had been expecting any issues encountered to have resulted from the introduction of new technology, rather than the students' research:

"I think it's more of a success for the medium than the actual content. [...] Maybe not what I expected, actually—in some ways maybe the opposite." - Teacher 3

T3 argued that without the deeper integration of research and knowledge into the Activities, they are of little value:

"It needs to be worth doing: there's no point in having all of the bells and whistles if there's no substance." - Teacher 3

They also argued that this could likely have been improved through a reconfiguration of the PBML framework to offer more structure:

"It's worth cogitating about what parameters you probably need to introduce, to guide them towards deeper thinking. I know that if that had been more free-form and open-ended, that would have been rather worse." - Teacher 3

T3 suggested that when applying content knowledge to Activities, a balance needed to be struck between a more guided, restrictive approach and supporting students' creativity and autonomy:

"If they were highly creative and lost their focus, then they'd be miles [off]. If they were less creative, but focused on the nature of the content, they'd probably find it easier to transpose. What we want is something in-between." - Teacher 3

8.3.3. Configuration 2: Full Process

After considering the above findings from the first studies, I developed the *Prototyping* stage of the framework. The jigsaw prototyping activity was introduced in an effort to assist students in giving their Activity's structure greater consideration, in response to Teacher 3's feedback regarding the need for greater project structure.

I worked with two different schools over an extended period of time (10-12 hours of sessions per school, spread over several weeks) to deliver a more fully-implemented version of the framework. This was partly supported by the fact that we were working with Year 4 (age 8-9) classes—as less focus is placed on preparing for examinations, we've found over the course of the OurPlace project that pre-secondary school teachers are more willing to engage with experiential forms of learning. Both schools welcomed the implementation of a longer project over several sessions.

School 4: Context

The first of these schools (School 4) was based in a tiny remote rural village in the North of England, which offered relatively few places of interest—especially in comparison to the setting of School 2. We worked with the entirety of the Year 4 group, who were the oldest children in the school (age 8-9, N=7). Because the school's population is so small, Year 3 and Year 4 share the same classroom, with the class's lessons being adapted to include varying difficulties for the two age groups.

In response to a separate OurPlace workshop we had held in an attempt to recruit teachers, the class's teacher (Teacher 4, T4) had approached us about using the OurPlace app with the school. They were particularly interested in using OurPlace and PBML to augment orientation and map-reading with new technologies in lessons. I drove out to meet with Teacher 4 at the school to plan out the study's time-frame and what the students' projects would be about. With a generous scope and large amount of time available, we decided that the students would do two projects: one to learn the mechanics of making Activities, and another which focused on their village's heritage.

School 4: PBML Engagement 1

Demonstrating the Medium	*Researching the Domain*	*Prototyping*	*Creating & Refining*	*Sharing in the Wild*

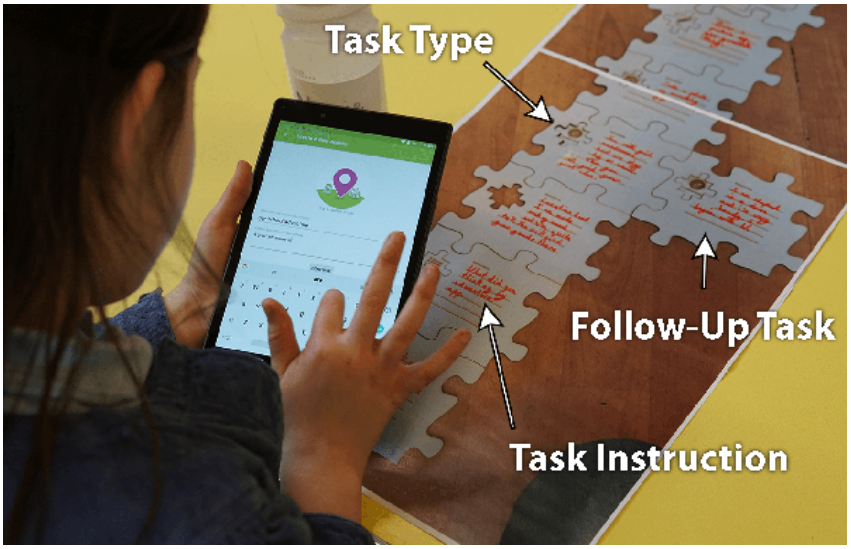

Figure 8.3 A student uses a photograph of her jigsaw prototype as a reference for creating an OurPlace Activity. When she ran out of *Location Hunt* pieces, she simply wrote the Task Type on the Task piece.

For the first project with School 4, we tasked the Year 4 students with individually creating OurPlace Activities for their younger classmates to complete around the school grounds. As with School 3, the first two-hour session started *Demonstrating the Medium* through an example Activity. The remainder of the first session was then spent on *Prototyping* phase, as these first projects didn't require any research.

In the second two-hour session, the students used their jigsaws as references to assemble their OurPlace Activities (Figure 8.3). The second session concluded with the students testing out their Activities and making refinements where necessary.

The final two-hour session of the project was spent by the students sharing their creations with their peers: the Year 4s accompanied rotations of small groups of younger students as they completed their Activities around the school, with groups being swapped to allow all students to try each Activity. The Year 4s were given the responsibility of showing the younger students how the app worked, and assisting them if they got stuck (Figure 8.4). At the end of the session the Year 4s hosted an assembly, where they showed the rest of the school their jigsaws and the teachers asked them questions about their experiences.

School 4: Engagement 1 Results

While the students initially struggled conceptually with the jigsaws due to their abstract nature, after a few minutes they understood the links between the puzzle pieces and the

structure of the app. The children all settled on creating some form of 'adventure', where each Task was a riddle to solve in order to find locations within the school. Tasks included finding QR codes around the school, photographing particular objects in response to riddles, and finding specific locations using *Photo Match*. I observed that the students' Activities made use of most of the different Task Types available, which may have been encouraged by the jigsaw packs having a limited quantity of each Task Type piece, forcing students to diversify (however, some students overcame this by simply not placing a Task Type piece if their chosen one wasn't available–see Figure 8.3 as an example). This highlights the potential for prototyping in a physical medium to provide constraints, which could encourage creative thinking if configured correctly.

When transferring their jigsaws into the OurPlace app, one student required help from a teaching assistant, but the others were happy working independently, reporting that their jigsaws made learning the creation process '*much easier*'. The children enjoyed exploring what they could do with the technology's functionality: for example, one student's final *Listen to Audio* Task 'rewarded' the user for completing their Activity with a recording of them singing the song *Celebration* by Kool & the Gang. After trying their activities, some light amendments were made, mostly involving spelling errors and reordering Tasks.

Prior to the third session, T4 briefed the younger students, giving the Year 4s positions of seniority and highlighting their efforts:

> *"You really need to listen to what [Year 4] have to say, because they have designed this themselves. They are your teacher, OK? Please listen, because they've worked really hard, and they're really excited about you having a go." - Teacher 4*

The younger students were very enthusiastic, and were keen on making sure they completed each of the Year 4s' Activities. During the Year 4s' assembly (Figure 8.5, they showed the other children their jigsaws and shared what they most enjoyed ('*I enjoyed being the teacher'; 'Being outside'; 'I enjoyed making the Activity itself*') and the younger children gave them feedback ('*Our favourite was [Susan's], because we got to find lots of things'; 'I really liked the beeping one, the Location Hunt*'). The school's headteacher praised the Year 4s' independent work as showing maturity:

> *"We can trust you to do something away from the class teacher and still do something really good. I think you really are stepping up to be Year 4s, it's wonderful to see. [...] If you're very grown up, you get to do very grown up things. So let's give Year 4 a clap." - School 4 Headmaster*

Figure 8.4 A Year 4 student reveals a clue to some younger classmates, leading them to the mobile learning activity's next objective.

Figure 8.5 The Year 4 students getting ready for their school assembly, during which they used photos of their prototypes to talk about their created Activities.

T4 also praised their leadership, and noted that when combined with OurPlace, the PBML structure supported the students in producing a varied output:

> *"I would like to also point out how good they were as teachers, as well. They really came into their own. I was very proud of them [...] They were very different as well weren't they? The ideas. Even though you all started off with the same tools." - Teacher 4*

School 4: PBML Engagement 2

Demonstrating the Medium	***Researching the Domain***	*Prototyping*	***Creating & Refining***	***Sharing in the Wild***

Following the success of the first project, Teacher 4 was excited to start the second one. Prior to the start of the new project, they preemptively collected a number of historical resources relating to the area, including newspaper articles, photographs and a book detailing the village's buildings. As T4 claimed to not have much prior local historical knowledge, this also served as their introduction to the village's heritage: a process that they claimed to particularly enjoy. Teacher 4 proceeded to make a shortlist of the more interesting buildings (such as an old blacksmith, a pub and a post office), shared these with the Year 4 students, and then took them on a short walking trip around the village so that all of the children had first-hand experience with the sites. Each child chose a different location to base an Activity on, using the walk and the teacher's resources to research it.

The engagements then aimed to follow the PBML process as before, culminating in the Year 4s' Activities being shared with the younger students in three groups, with each group accompanied by an adult and sharing tablets one-between-two.

School 4: Engagement 2 Results

For this second engagement, the *Demonstrating the Medium* stage was skipped, as the group were already familiar with the app. When I asked the students if they would find it helpful to plan their Activities out using the jigsaws as they had done previously, they said no: they'd rather jump straight into making them using OurPlace, as they were already comfortable creating and editing using the app's tools. The Activities were produced over three hours between two sessions. All of the children's Activities featured *Location Hunt* Tasks guiding the learner to their chosen location, with further details delivered through *Information* and

Listen to Audio Tasks. Less passive Tasks included asking the learner to draw details from the location, and a *Multiple Choice* quiz based off given information.

The students then shared their Activities with the younger students in the last 90 minutes of the second session. The groups completed each of the 7 Activities around the village before returning back to the school. Teacher 4 was pleased with the Activities, noting that the process acted as a medium through which the class were able to engage with local heritage, and create and share artefacts they could be proud of:

> *"The children were able to engage with the local history in a way which they enjoyed, and they've taken pride in sharing their work with the Year 3s." - Teacher 4*

After the trip, several of the Year 3 students asked if they could make their own Activities the following year.

School 5: Context

I approached another Year 4 teacher (Teacher 5, T5) at an inner-city school (School 5), after their class had shown an interest in local history by successfully campaigning for the installation of a commemorative plaque celebrating a notable slavery abolitionist who had lived near their school. This was particularly relevant to School 5, which serves a large number of families of Nigerian descent. T5 was particularly enthusiastic about the concept of producing Activities relating to the area's numerous other plaques. I worked with the majority of the school's Year 4 (age 8-9, N=21, led by Teacher 5) and Year 6 (age 10-11, N=32, led by Teacher 6) students, who worked together on the project in 14 mixed groups of 3-4 (the sessions took place during a period where a group of the Year 4 students were offsite doing extracurricular activities, and so did not take part in the study).

School 5: PBML Engagement

Demonstrating the Medium	***Researching the Domain***	***Prototyping***	***Creating & Refining***	***Sharing in the Wild***

As with the previous schools, the students used a demonstration Activity as an introduction to OurPlace. Following this, Teacher 5 explained that each group was to choose and research one of the historical figures commemorated by the plaques in the area, and produce an

Activity related to them. Over the following week, the classes' teachers dedicated several hours of class time to researching and visiting the plaques.

As with the first engagement with School 4, the full PBML process was followed. After the demonstrating the medium and research stages, the groups spent an hour's session designing their jigsaws. The completed jigsaws were photographed and used as references for creating the Activities in a third hour-long session later the same week. The final session of the project involved the students going out into the neighbourhood, splitting into groups to visit the plaques and complete each other's Activities.

School 5: Results

As a result of the lengthy research stage, by the second session each group had prepared several pages of notes relating to their chosen plaque and were ready to start designing their Activities. The School 5 children found it helpful to have a tablet for reference while constructing their jigsaw prototypes, and frequently referred to their notes while writing their Tasks.

As was the case with School 4, the transition from jigsaw to the app went smoothly. Part of the third session was also spent visiting the plaques with the students, so that they could test and refine their Activities, get accurate GPS readings and take photographs to include in them. Examples of the final Tasks included asking learners to *Record Video* of interviews where students role-play as their plaque's person of interest, and Follow-Up Tasks quizzing learners about the contents of *Listen to Audio* narrations. Some Activities lacked content, which T5 attributed to a lack of available information for the chosen plaque's subject and some children's behavioural issues.

When asked what their favourite part of the project was, several of the students mentioned that they particularly enjoyed sharing Activities:

> *"[I most enjoyed] today, getting to go around and swap with other people and getting to find out about theirs." - School 5 Student 1*

They also felt that swapping Activities was an important part of the process, as it could also share different ways in which the Task Types could be used. Furthermore, one Year 6 student noted that OurPlace could be used to share the value of place with visitors and other communities:

"I think that if we made stuff for another school that made them learn, it would be really good because you could make it about your school." - School 5 Student 2

Teacher 6 expanded on this concept, identifying that the use of OurPlace within PBML could be a suitable medium for civic learning:

"That would be an interesting thing to do, wouldn't it? To swap it and see what their daily life is like and what yours is like." - Teacher 6

During a follow-up interview, T5 reported to particularly like tactile nature of the jigsaw prototype:

"Doing it on a piece of paper is very boring, so to get them to understand that the order can matter... I think that's a very good, visual way of showing the children. That really worked." - Teacher 5

Unlike the children in School 4, T5 also saw value in doing the prototyping for making further Activities: they saw the jigsaws as a method for prototyping Activities, rather than simply a way of easing the students into the application's structure.:

"I would use the jigsaws every time. Because it's a different Activity." - Teacher 5

Following the study, T5 requested a digital version of the jigsaw format, so that they could print copies for students to prepare future OurPlace Activities outside of the study period. T5 also saw a potential value in exchanging with separate groups of students, and lamented the fact that it hadn't been explored further during the project:

"I think it would have been better if we'd done it, and then taken a different group of children out to use it. So you do it with one class, then take the other class with them to show it. And then they can evaluate by watching the other child. But it's just time pressure, isn't it?" - Teacher 5

As evidenced by their prior usage of the plaques as a resource for PBL and civic engagement, Teacher 5 was also highly favourable of teaching in authentic contexts and using the children's existing relationships with place:

"It was all about taking a context specific approach, that's what I'm really into. These children know about their local area, and that helped us scaffold the Activities." - Teacher 5

Teacher 5 also noted that many of the children were not aware of the area's history, and—particularly given the heritage of many of the students—that the historical figures could act as inspirational role models:

"This is where the children live, so it's really important that they understand the history of it. Really great people who're like them have lived in this area." - Teacher 5

Furthermore, working in these environments brought the children in contact with community stakeholders:

"They got to meet people when they went out and about. They met the guy who's raising money for the sculpture in the middle of the park." - Teacher 5

Teacher 5 also argued that using constructionist mobile learning techniques in a PBL approach helped leverage these civic resources in lessons, as the creation of public entities—rather than simply learning for the sake of learning—acted as a motivating factor:

"It was how we were going to bring those [resources] into our lesson. I think that OurPlace really helped: it gave us a focus to do the history through the app, rather than just go and collect the information and then—what do we do with it?" - Teacher 5

8.3.4. Configuration 3: Without Demonstrating the Medium

With the full version PBML framework now seeming to perform fairly well, I was interested in applying it in other teaching contexts in order to see how it might be adapted to meet different contextual challenges. Inspired by the use cases hypothesised by Teacher 5 and Teacher 6, I was also interested in exploring the potential roles for PBML and mobile learning technologies in projects which focused on civic-learning oriented objectives.

Through discussions with Teacher 5, we discovered that they lead a summer school for children of families who run the local annual funfair. Following our engagements with School 5, we were invited to run a short engagement with a group of these children (age 6-9, N=16) attending the summer school.

Travelling Showmen: Context

The students attending the summer school were the children of Travelling Showmen and Showomen, members of the Showmen's Guild: a trade association made up of traditionally insular cultural groups of families, who travel around the UK to run funfairs and circuses. While the children of these families (Showchildren) are registered with traditional schools, the families travel so frequently (one family claimed to work 40 events a year) that their schools send out packs of educational materials for the children to work on remotely. During an interview following the previous study, Teacher 5 claimed that they didn't think much of these teaching materials and derided the worksheet-based packs as uninteresting:

> *"[The school packs] are super boring and often rubbish. Some schools are alright, but it's still working from a piece of paper." - Teacher 5*

This was a sentiment that Teacher 5 shared multiple times throughout the study, and they were enthusiastic about providing the children with more interesting activities to complete during their time at the summer school. Inspired by Teacher 6's suggestion that OurPlace could be used as a medium through which daily life experiences could be shared, T5 suggested that we do a short project at the summer school as a form of cross-cultural learning:

> *"Their lives are so different, it would actually be a nice tool to share with other children what it's like to be a Showman." - Teacher 5*

We arranged a trip for Teacher 5's Year 4 class from School 5 to visit the fair, where the Showchildren would introduce them to their ways of life. Prior to the trip, the Showchildren would create OurPlace Activities, with which Year 4 could also collect data for use in classroom projects back at school. To facilitate this, the research team funded a coach to transport the class to the fairground, as well as the usual use of tablets and WiFi router.

Travelling Showmen: PBML Engagements

As the summer school only ran for two weeks, we only had one three-hour session in which to introduce the Showchildren to OurPlace and have them create Activities. Following the issues found in the configuration used in School 3, we decided to try another, skipping *Demonstrating the Medium* and relying on verbal instruction during the *Prototyping* stage as an introduction to the app's functionality. Unfortunately, due to the fact that the entire session could only last a couple of hours, the Showchildren were unable to test their Activities outside and refine them.

Later the same week, I ran a session in School 5 to introduce Year 4 to the concept of Travelling Showmen. This took the form of asking the class a series of questions for open debate, querying: what they knew about the Travelling Showmen community; the students' experiences with them and the fair; what they imagine Showman life would be like; what the students most enjoy about living a settled life in their city; and if they think they would enjoy being a Showman. These questions were chosen to both get an understanding of the students' prior knowledge about the Travelling Showmen, and also to get them reflecting about how their lived experiences of place might be different to those of the Showchildren. For the Year 4 class, the trip would act as the *Research* stage within their own class project. To help with data collection and encourage fruitful conversation between the two groups of children, we asked the students to prepare some questions to ask the Showchildren.

The trip occurred the following week. An education specialist from the Showmen's Guild gave a short talk to the children regarding Showman ways of life, and their experiences growing up within the community. Following this, the Showchildren and Year 4s were put into mixed groups of 4–5. Each group were given two tablets with the Showchildren's Activities, and the Showchildren were asked to guide the visitors around the fair. The Year 4s also used the Showchildren's Activities for their data collection, using the app to catalogue photos of the different rides and using *Record Audio* and *Record Video* Tasks to capture the Showchildren's responses to their prepared questions.

Travelling Showmen: Results

After I gave the children a brief demonstration and explanation of OurPlace's functionality (without the children going hands-on with the devices), the Showchildren were able to

complete the jigsaw activity without first needing to use the application. The children largely gravitated towards making Activities which focused on their families' rides and stalls within the fair. For example, some children created *Information* Tasks about their families, while others created *Record Video* and *Take Photos* Tasks asking the user to capture their families' rides in action. Transitioning from the jigsaw prototypes to the digital versions went similarly to the previous engagements, suggesting that the jigsaw serves as an intuitive metaphor for the application.

Back in School 5, the Year 4 class's discussions largely centred on the concept of the Showchildren working in the fair, an idea which appeal to them: one child noted they wanted '*to get money to support my family*'. However, there was a concern that as children, they wouldn't be treated as equals by adults: '*you might not get paid as much, because people could want to only go to adults and think that children are not responsible yet*'. The children found the idea of inherited careers generally unappealing (most Showmen families have an occupational lineage of several generations), saying '*I don't want to do my parents' job*', and '*it's natural to want to do something different, [...] if you just carried on a tradition you might not really like it.*' Many of the questions they prepared to ask the Showchildren revolved around the Showchildren's independence and influence in the community (e.g. '*Have you ever designed a ride?*'), their work-life balance ('*Would you like shorter or longer shifts?*') and their earnings ('*How much money do you earn?*'). Comparatively few of the questions focused on social aspects of the Showmen community (e.g. '*Do you have any relatives who are in a different part of the world?*').

However, once they had spent some time with the Showmen community during the trip, most of the questions had shifted to being about the lived experience of the Showchildren ('*In a year how many places do you think you travel to?*', '*Do you get to make many friends outside of the fair?*'). The Showchildren also responded with some questions of their own, querying the Year 4s' experiences with the funfair.

One of the Showchildren was particularly excited for the students to complete a 'Scan the QR Code' Task, which asked them to find the child's parents' ride. However, when it was scanned they were disappointed to find that it didn't unlock any content, as there were no Follow-Up Tasks set. When this was explained, they didn't know what Follow-Up Tasks were: '*What did you mean by follow-up? How do you put something in it?*' While disappointed, the child expressed interest in downloading OurPlace to make Activities at home.

8.4. Discussion

These studies have shown that configuring the PBML framework differently can meaningfully impact students' engagement with and knowledge of the domain and technology. This section discusses the three themes resulting from the inductive thematic analysis conducted on the above findings with exploratory, line-by-line coding: *Configuration and Compromise*, *Harnessing Students' Desire for Independence*, and *Leveraging Place through PBML*.

8.4.1. Configuration and Compromise

In these studies it was necessary to adapt the proposed framework in response to each teaching context's limitations. For example, Schools 2 and 3 were severely limited in how much time they could dedicate due to obligations to follow a strict curriculum, and the Showmen's summer school was only running as long as the funfair was in town. It was only when working with the younger classes in Schools 4 and 5 that more time could be afforded. This was certainly not ideal for PBL-style engagements, which should engage students over the course of an extended period of time (Blumenfeld et al., 1991). Nevertheless, I argue that teaching contexts are rarely ideal, and so approaches to working within them should be adaptable and open to compromise. In line with the design-based research approach, I wanted to explore this by implementing the framework in various real contexts which necessitated its adaptation.

The results suggest that skipping the prototyping stage of the PBML framework in School 3 contributed towards the lack of engagement with the domain, putting the students' main focus on the technology itself. Before taking the project away as homework, the last engagement the students had with the project was the technology's demonstration, meaning it was likely to take centre-stage in their minds. Our observations at Schools 4 and 5 suggest that inclusion of the prototyping jigsaw exercise may have brought the School 3 students' focus back to the domain's content, as—while still making sure the students were working within the structure of the application—it encouraged the students to concentrate on the Activity's content, rather than the novelty of the technology. This could be most clearly seen in School 5, where many of the students opted to have their research notes open for reference during the *Prototyping* stage.

The studies also highlighted the value of students sharing their creations with their classmates and/or the wider community. Students from Schools 4 and 5 emphasized the exchanging of Activities as being a particular highlight of their experiences, with students keen to both

see what their peers had produced and also show off their own creations. This supports similar findings from previous research, held outside of the place-based mobile learning context (Heslop et al., 2017; Sarangapani et al., 2018). Teacher 5 noted that had time allowed, they would have extended this sharing stage to support peer feedback between classes and groups. For the School 3 students, the lack of emphasis on sharing the created Activities with their peers or outside communities may have also reduced their value as constructionist public entities (Papert and Harel, 1991). Even though the Activities produced by the School 2 students consisted of minimal content, the students benefited from being able to exchange their creations with their peers, complete them in an authentic learning environment, and use them to assist in engagements with the stakeholders.

In response to these findings, our other time-limited engagement with the Showmen's summer school used a different configuration which skipped *Demonstrating the Medium*, instead focusing on the *Prototyping* stage. While the jigsaws seemed to provide a somewhat serviceable introduction to the app due to the closeness of its metaphor, the full capabilities of the technology had evidently not been made clear to the Showchildren. In the case of the Showchild with the QR code, this resulted in a degree of frustration and disappointment that their Activity wasn't as fully featured as it could have been. It's unsurprising that more advanced functionality, such as Follow-Up Tasks, would be unclear to children without first demonstrating them in an example Activity.

Each configuration held its own compromises, resulting in an interesting balancing act between four elements:

- **Understanding of the technology**

  E.g. Omission of the *Demonstrating the Medium* stage in particular led to not using the platform to its full potential.

- **Understanding and application of content knowledge**

  E.g. omission of the *Prototyping* stage led to shallow public entities, which focused on the technology rather than the content.

- **Sharing creations in authentic learning contexts**

  E.g. omission of the *Sharing* stage reduced the value of the entity creation process, with students unable to exchange their creations, knowledge and feedback in the authentic learning environment.

- **Classroom time**

The amount of time dedicated to the PBML process—too little means compromising on at least one of the above factors.

The balance of each of these factors across these studies is illustrated in Figure 8.6. Each of these elements was shown to be important, and compromising on any of them while still producing successful PBML engagements was difficult. However, successive projects can mitigate this by omitting certain stages as the learners become more experienced. This was shown in the second set of Activities made at School 4, where the students opted to skip the *Demonstrating the Medium* and *Prototyping* stages. Even this was up to some degree of teaching interpretation, as Teacher 5 noted they would use the jigsaw prototypes each time their class made new Activities.

Further workarounds and compromises could also be explored: for example, in an effort to avoid repeating the rushed Activities created in School 2, Teacher 3 opted to make the *Creating & Refining* stage a homework activity, saving on classroom time but still allowing for longer engagement with the project. However, while this would theoretically reduce the impact that a lack of classroom time might have on the PBML process, it also raises issues around remote support and ensuring equal access to technology resources. This could highlight economic disparity between students, potentially leading to issues such as bullying. As products such as smartphones have become something of a fashion accessory and status symbol, I would hesitate to recommend creating a school environment which risks othering low-income students by highlighting ownership of these material possessions. Furthermore, Teacher 3 was particularly hesitant to recommend students create Facebook or Google accounts in order to use OurPlace, due to concerns over them volunteering personal data and risking their privacy under the teacher's instruction. Taking up teaching time by using these mobile learning technologies within the controlled school environment is its own compromise, however it allows many of these issues to be mitigated.

I suggest that researchers and practitioners should weigh-up these compromises when configuring the framework according to their own motivations. For example, if full utilisation of the technology's potential isn't a priority, then the impacts of omitting *Demonstrating the Medium* become less of a concern. Likewise, skipping the *Prototyping* stage might be acceptable if the use of the technology is one of the main learning goals. However, I argue that omitting the other stages should be avoided as they are either key to the PBML process (research, creation) or major motivating factors (sharing public entities).

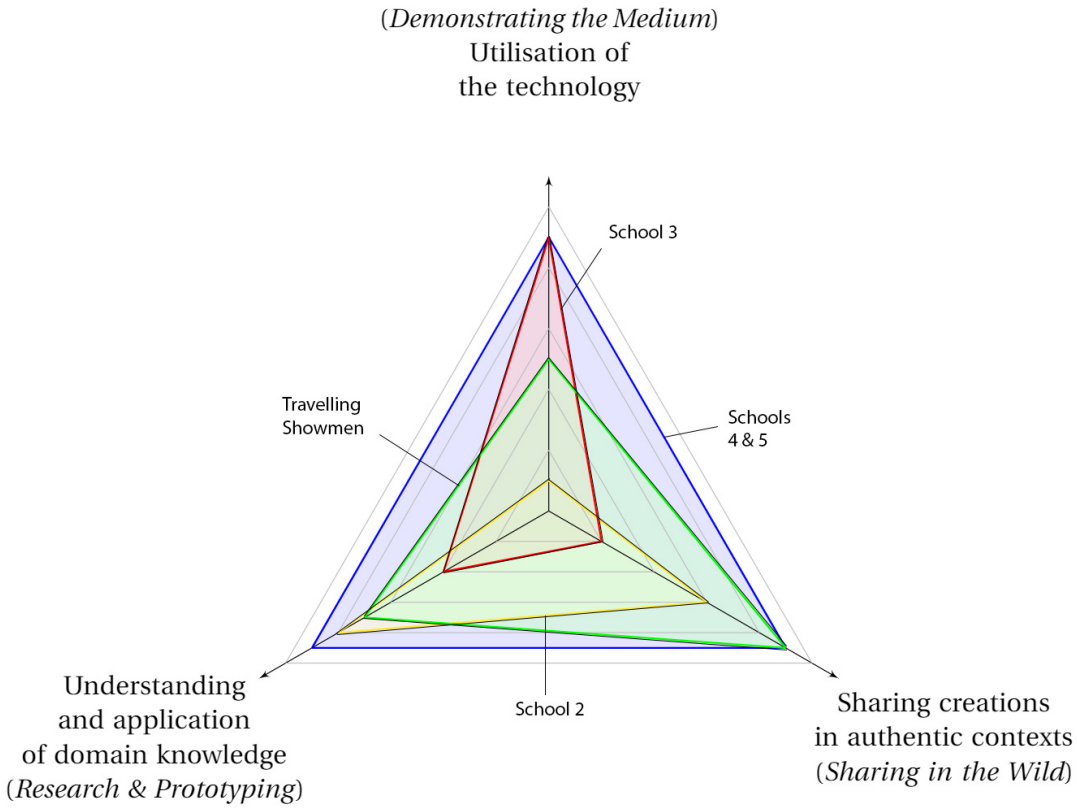

Figure 8.6 A radar chart illustrating the compromises of the trialed PBML configurations (Yellow: School 2; Red: School 3; Blue: Schools 4 & 5; Green: Showmen Summer School). Students could gain a greater understanding of the technology through the *Introduction to the Medium* stage, the *Prototyping* stage encouraged the meaningful application of their domain knowledge to their Activities, and the students found that the *Sharing* stage helped make the process more meaningful, as well as supporting learning in authentic contexts. A significant investment of teaching time was required to be successful in all three, otherwise at least one area would be compromised.

8.4.2. Harnessing Students' Desire for Independence

In these studies, many of the students we engaged with had a great desire for independence and to be respected as individuals. This was particularly evident in the School 5 class's fascination with the Showchildren's contributions to their family businesses, their lamentation at their lack of perceived responsibility when compared to adults and a desire to walk their own path rather than simply emulate their parents.

The PBML process capitalised on this quality, granting the students greater control and autonomy over their work (Noss and Hoyles, 2017; Wurdinger et al., 2007), and enabling them to approach creating Activities with greater degrees of personal input (as had been shown in the studies covered in Chapter 4). This could be seen in some of the personal touches put into their Activities, such as the Year 4's rendition of *Celebration*, or the Year 8's usage of their YouTube characters. These flourishes—alongside the uniqueness of each Activity—suggest that OurPlace conforms to Noss and Hoyles' requirement that constructionist tools should be expressive enough to support exploration and ownership through construction (Noss and Hoyles, 2017). This also echoes the previous research covered in Chapter 7 held with ParkLearn, in which students' sense of ownership of their responses to others' Activities was an important contributing factor towards their enthusiasm, thanks to greater degrees of freedom and independence. Furthermore, the students' investment in their projects supports arguments that the greater autonomy afforded by PBL, as well as tapping into students' fluency with technology, can result in indicators of greater student engagement (Bell, 2010; Wurdinger et al., 2007).

When sharing their Activities with their peers, the students were clearly proud of their creations and enjoyed taking a 'teaching role': they took care to guide the other students through the Activities to avoid them getting stuck without being overbearing (shown in School 4, e.g. Figure 8.4). The School 4 teachers rewarded the students' performance by playing to their desire for perceived maturity, noting their growing trust in the children to perform independently and recognising their seniority amongst the students. This feedback also served as qualities for the younger students to aspire towards—some of the younger students later enquired about making their own Activities when they're older. This move to reposition the Year 4 students from a 'consumer' role to one of mentorship—in which they have a degree of authorship over teaching materials—mirrors the study by Massey et al., in which the authors argued that the students were re-framed from end-users to software developers and decision makers (Massey et al., 2006). In both cases, the learners were empowered through the creation of public entities to be able to take an active decision-making role in how technology

could be used within their learning environment. The addition of the sharing stages took this a step further, granting the students the gratification of seeing others enjoy their creations.

These findings lead me to suggest that future mobile learning designs can harness students' desires for independence as a motivational force by granting them opportunities for autonomy and personal flourishes, as well as platforms through which to share these personal creations. Within these studies this was achieved through a combination of technology, configuration, and context: OurPlace elevated students from consumers to producers by granting them creative control, and the creation and sharing of public entities in authentic contexts at the culmination of a PBML process bolstered their self-worth and empowered them through positions of mentorship. However, it's also worth noting this approach may not be conducive to success in all contexts, as teaching styles and cultures within different schools may be at odds with it or require re-balancing. For example, Teacher 3 was in favour of greater scaffolding, and believed that further student autonomy would be detrimental to their output. This makes sense when considering the school's almost exclusive focus on preparing students for future examinations.

8.4.3. Leveraging Place through Project-Based Mobile Learning

During these studies, the project-based mobile learning process offered new ways and motivations for the schools to engage with their area's local heritage and community, surfacing 'new' educational resources which had previously gone underused. For example, Teacher 4 reported to previously know very little of the village's local history, and School 5 hadn't previously made use of the commemorative plaques as learning resources. Teacher 5 argued that using OurPlace to create the public entities gave lessons a focus and motivation needed in engaging teaching sessions, as simply collecting information would have felt aimless. Teacher 5 was also ardently in favour of the students learning more about their local context, as the historical figures within the area could serve as inspirational role models. Finally, in the Showmen study, a (compressed) PBML process also supported exposure to (and greater understanding of) another community's heritage. The students' preconceptions regarding the Showchildren were corrected following technology-mediated personal interactions with the community, and their topics of interest shifted over the course of the study: from the *practical* to the *lived* experience of being a Showman.

I argue that PBML is particularly well suited to leveraging these local resources, as it combines the advantages of constructionism and project-based learning (supporting the ownership and exploration of ideas through the construction of public entities, in a process which

encourages student inquiry and autonomy (Larmer and Mergendoller, 2019; Noss and Hoyles, 2017)) and those of situated, outdoor learning (experiential learning, embedded in authentic contexts (Lave, 1991)). As discussed in Chapter 7, mobile learning technologies are uniquely suited to assist this process due to their ability to leverage these authentic physical and social learning resources and support greater degrees of student control, communication and creativity seamlessly across different learning environments (Sharples et al., 2007). Despite this, as noted by Chan et al., the use of mobile technologies in project-based learning has been under-researched (Chan et al., 2015). Given these apparent advantages, I would like to see future research explore how PBML could benefit from other technologies which support the creation and sharing of place-based interactive content, rather than simple knowledge consumption or the creation of passive artefacts (e.g. blogs). For example, through the PBML process students could research and create their own place-based Zydeco (Cahill et al., 2010) projects for their peers to respond to. Another less mobile example could be having students research and create place-specific content for their own digital installations through the use of systems such as Science Everywhere (Ahn et al., 2018). While these studies used OurPlace to develop the PBML framework, it has clear potential to be applied and further developed through the use of other technologies—be they new, or previously existing.

8.5. Summary

Inspired by the use of OurPlace as a component within larger projects (discussed in Chapter 7), I wanted to explore how mobile learning technologies could be used as a tool within each stage of project-based learning pedagogies. This chapter reported on the design and evolution of a framework to structure 'project-based mobile learning', evaluated over the course of four studies in distinct learning contexts. Following a design-based research approach, the framework was configured in response to the demands of each context in order to understand its performance within real-world educational environments and updated in response to the findings of each study.

These studies further highlighted the importance of understanding the potential variations in design contexts when designing processes and technologies. Each context offered its own resources and limitations, meaning that the framework had to be configured to fit the particular demands of each. These re-configurations were shown to potentially compromise the learning experience, albeit each in a different way, which—depending on the teaching goals—may or may not be acceptable.

This chapter also discussed how the project based mobile learning process can harness students' existing desires for independence as a motivational force by granting them opportunities for autonomy, creativity and personal flourishes. Finally, the chapter discussed how PBML offered new avenues for schools to leverage their local heritage as learning resources, and argued that the potential roles for mobile learning technologies within project-based learning processes should be further explored.

Chapter 9. Discussion and Conclusion

This research has taken place against a backdrop of political and financial uncertainty for much of the UK. The two main demographics that this project engaged with—volunteer-driven heritage preservation groups, and teachers within the formal education system—have both been impacted in recent years by pressures imposed by top-down institutional policy, and funding cuts made to cope with austerity measures. In response, these groups have started to look towards more sustainable methods of utilising existing resources and novel methods of engagement. Mobile technologies clearly have a potential role in this space: their growing ubiquity in society, as well as the popularity of location-aware applications such as *Pokémon Go*, have meant that a large number of community groups that this project engaged with were actively seeking to be represented through mobile applications. Similarly, the utilisation of mobile technologies in schools has gained popularity—both for data collection on school trips, and in the classroom for research and content creation.

This project has aimed to explore this context as a design space for mobile learning technologies which harness places—and the communities that care for them—as resources for both learning within the formal education system, and informal knowledge sharing within wider communities. Furthermore, I wanted to explore how such technologies could be used by place stakeholders to further their groups' interests and agendas, and how such mediums could be used to share their outlooks and values with new audiences. While I regard the primary contribution of this project to be the 'project-based mobile learning' framework discussed in the previous chapter, another significant contribution is the set of implications for design described below: each use the above contexts and aims as a backdrop, and discuss their relation to the identified findings from the previously discussed studies. I also discuss some of the study's limitations, before concluding by responding to the research questions laid out at the project's inception.

9.1. Implications for Design

These discussions will pertain to how mobile learning technologies can be configured to support place-making, and recommendations as to how researchers and designers can better utilise the infrastructures of place as resources for civic mobile learning.

9.1.1. Support Place-Making with Mobile Learning Technologies

This project has highlighted numerous ways in which mobile learning technologies can be configured to effectively support place-making. As such, I've broken down this implication for design into six suggestions: *Encourage Encounters with New Interpretations of Place*; *Highlight Place Attachment & Meaning*; *Support Celebrations of Imperfection*; *Promote Engagement with Communities of Practice*; *Treat Mobile Learning Content as Living Media*; and *Support Independent Expression & Reflection.*

Encourage Encounters with New Interpretations of Place: Our relationships to place are molded by the experiences and familiarity we have with space. As Tuan posited: '*What begins as undifferentiated space becomes place as we get to know it better and endow it with value*' (Tuan, 1978). Similarly, Relph argues that the process of building a relationship with space involves encountering and having experiences with it (Relph, 1976). Furthermore, he notes that the majority of the experiences that people had with the landscapes around them in the 1970s were mediated by machines—he noted that while it is easy to view this as a factor which acted as a barrier separating people from authentically experiencing place, technologies such as cars opened up new opportunities for people to experience spaces that had not previously been accessible to them. Today, it's evident that mobile technologies play the same role—simultaneously erecting barriers to distract people from authentic experiences in place, and opening up new opportunities to encounter places which would otherwise be too remote or abstract to be easily accessible. While we must be aware and wary of the former, the latter presents new and exciting opportunities for using technology to support place-making processes. For, unlike the automobile, digital technologies allow users to traverse more than just physical distances: they can be configured to support encountering different interpretations of place, which may not have been previously accessible (or visible) regardless of physical proximity. This project has highlighted multiple examples of how mobile learning technologies can be used to platform or celebrate others' relationships with place, such as the rangers' concerns around park funding, the heritage forum's valuing of preservation and restoration of often inconspicuous locations, and the memorandum of the local impact of prior events, such as the miners' strikes or World Wars. While such place-making interactions

can be supported by non-mobile technologies (for example, the use of Google Earth VR by Jeff Gerstmann discussed in Section 2.3.2), the use of mobile learning technologies can also support the ability for remote place 'visitors' to respond to activities through the use of their own space/place context. For example, in Chapter 8 a student suggested creating and exchanging OurPlace Activities with other schools—using the app to compare and contrast their lived experiences with other people's, via a place they are remotely encountering.

Highlight Place Attachment & Meaning: As Tuan argues, people who inhabit the same physical space may, due to differing past experiences, associate the space with different meanings and values (Tuan, 1978). Giving stakeholders opportunities to share these experiences with others can make their understanding of a space as a place less abstract, and help them understand what makes that place special. I argue that the studies presented in this dissertation have demonstrated that mobile learning technologies such as OurPlace can be used as platforms to offer these opportunities. These studies showed how the creation of mobile learning activities can give opportunities for highlighting and sharing *place attachment* and *place meaning* (Kudryavtsev et al., 2012). Place attachment—the degree to how much someone values or identifies with a place, due to it fulfilling their needs or defining them as an individual—was demonstrated through the use of the app by park volunteers in Chapter 6 to highlight their group's efforts and attempt to recruit new members. Meanwhile, place meaning—the meanings that individuals ascribe to settings that they are familiar with, reflecting their environment, social interactions, culture, politics, economics and history—was seen through the use of the app to discuss notable figures in local history in Chapter 7, and by the Showchildren in Chapter 8 to introduce their ways of life. This is not unique to OurPlace: another example is Balestrini's CrowdMemo project, during which a mobile technology acted as a platform for community storytelling (Balestrini et al., 2014). As with Crivellaro's walking trail (Crivellaro et al., 2016), the mobile nature of OurPlace also supports genuine engagement with the environment, with many of the app's Task Types encouraging learners to pause and reflect in-situ. I argue that the deliberate exposition of these factors through technology introduces opportunities for learners to interpret others' place-based experiences: informing their own place-making process with the values of other stakeholders.

Support Celebrations of Imperfection: Using mobile technologies to highlight place attachment and meaning could be particularly useful when used in places which are 'under appreciated'. For example, during the ParkLearn workshop covered in Chapter 6, volunteers referred to the value they held in the imperfections (such as generations old graffiti) of the places they cared for. In some cases, making these safe or suitable for physical public access could sanitise them, eradicating what made the places special to the stakeholders in the first place. In these instances, learning technologies offer a potential solution: allowing

people to remotely experience place they cannot physically access, supporting the building of vicarious insideness and support for preservation. More subversively, the grassroots nature of OurPlace's Activity creation process could also allow unofficial support for people entering these areas unsanctioned (something which the participants reported happened anyway). The ability to remotely open up these places without the need to sanitise their value could help counter Relph's concerns regarding 'placelessness': '*the casual eradication of distinctive places and the making of standardised landscapes that results from an insensitivity to the significance of place*' (Relph, 1976). This project's findings support those of Crivellaro (Crivellaro et al., 2016), suggesting that while content created top-down by institutions and local government would often be incentivised to present a sanitised interpretation of place, granting stakeholders direct control of the content creation process may result in a more authentic, 'warts and all' representation based on lived human experience.

Promote Engagement with Communities of Practice: A key advantage of mobile learning technologies is that they allow for users to engage in authentic learning contexts—in both the humanist geographer sense that they can provide 'genuine experiences' through unmediated access to place's social qualities and constructs (Relph, 1976), and also in the learning sciences sense, where Situated Learning Theory posits that learning frequently occurs through legitimate peripheral participation in communities of practice (Lave et al., 1991). Through supporting communities of practice in creating and sharing learning resources, mobile learning technologies make it easier for newcomers to engage in peripheral participation with those communities. Emphasising this link between the learning resources and the individuals and communities which create them further encourages the place-making process: learners are exposed to others' place attachment and place meaning, while also forging their own experiences in place via the technology medium. This exposure to communities of practice may not be immediately obvious to the learner—for example, the rangers and volunteers in Chapter 4 aimed to nurture an appreciation of their place within the schoolchildren, rather than recruit them as volunteers. Sometimes this may be more explicit, as in the case of the 'Talking Statue' project, where the OurPlace Activity included Information Tasks which described the volunteer group's work and how the user could get involved. However, even this was obscured behind the Activity's primary goal of delivering historical information about the park's heritage.

Treat Mobile Learning Content as Living Media: The combination of mobile hardware, wireless networking and easily configurable software enables these communities of practice to design and create novel interactions for use by others within an authentic learning environment. In this regard, OurPlace Activities could be classed within the scope of 'cross-media interaction', as posited by Giaccardi et al (Giaccardi et al., 2008). They argue that the use

of multiple forms of media and technology can create new forms of socio-technical infrastructure, allowing place-making through new cultural experiences and the exploration of people's relationship with place. Giaccardi et al. also argue the importance of making heritage a 'living practice' through repeated interactions over time, where people are given '*active and supportive roles, [engaging] them in connecting to each others' experiences, considering each other's interpretations, and building insights that may lead to new meanings and relationships.*' The use of OurPlace within schools shows how this might be put into practice, with the local heritage around each school acting as each class's focus for both research and creativity. The nature of digital content and school cohort systems also encourages this to be an ongoing, living practice: where each class experiences and builds upon the previous class's local heritage research.

Support Independent Expression & Reflection: As McCarthy and Wright argue, mobile phones and tablets are intrinsically personal devices which are particularly well suited to allowing for private encounters in public space and '*blurring the traditional boundaries between public and private, intimate and extraneous*' (McCarthy and Wright, 2005). They argue that technologies which engage people on a personal level can help them feel 'in place'. This focus on the individual experience of using technology can allow for explorations of private interpretations of place within public space. For example, RIOT!1831 allowed participants to privately experience an interactive play whilst in an authentic, yet public, space (Blythe et al., 2006). Similarly, Google Earth allows for the exploration of personal experiences in a virtual, dream-like representation of real public spaces, with some of the more abstract elements being up to interpretation (Gerstmann, 2016). Some of the usage of OurPlace mirrored these aspects of private experiences in and building of place: for example, one of the heritage workshop participants considered using OurPlace to subvert the usual bureaucratic system in place for choosing commemorative plaques, instead creating their own personal set of digital plaques independently. Other instances could be seen in schools' use of Activities, where students would retreat away from the main group to be able to record their thoughts and reflections without being interrupted or overheard. This focus on the individual is an important part of OurPlace—while many of the engagements involved participants creating Activities as a group, the application maintains the ability for individuals to use the technology as a platform for self expression within place, be that through creating their own Activities or responding to others'. Relph argues that by focusing on wider representation rather than recognising and representing individual viewpoints, we run the risk of highlighting an inauthentic identity which no longer represents anyone (Relph, 1976). However, Relph also warns that place can be misrepresented, either by those who are invested in its success or blind to its flaws—creating a more palatable, 'disneyfied' ideal. Studies such as those held by Crivellaro et al. might suggest that this is best combated by opening up the ability for all individual stake-

holders to create and share materials regarding their lived experiences (Crivellaro et al., 2016). However, this does not account for the fact that stakeholders cannot share what they do not know, and so may inadvertently create materials which do not give a complete representation of place. For example, Teacher 5's class created Activities relating to slavery abolitionists who had had a presence in the area—it is generally accepted that the North-East of England was a mainstay in the country for the abolitionist movement. However, the children were not aware that there had also been major businesses in the area that profited from the slave trade, including refineries of slave produced goods such as sugar and even ironworks which supplied slave restraints and plantation tools (Newcastle Literary and Philosophical Society, 2007). While much of the point of OurPlace is to allow for individuals to share personal interpretations of place (by definition subjective, and not impartial), these created Activities could be argued to give an incomplete (and rather charitable) representation of the place's heritage with regards to its relationship with slavery. I argue that this highlights a need for designs that promote thorough research amongst content creators, and critical reflection on the part of consumers of these generated materials.

This project has highlighted that place-based mobile learning technologies can be useful tools for supporting place-making processes. While many digital technologies can open up new opportunities for encountering place, mobile technologies are unique in that they offer the ability to also do this in authentic physical *and* social contexts, which has been argued to strengthen the learning and place-making experience. I argue that this project has demonstrated that technologies such as OurPlace can take this a step further: by supporting all users as creators of place-based mobile learning materials, OurPlace can also be used to highlight the place attachment and place meaning held by stakeholders, both as individuals and in communities of practice. These materials can act as new layers of socio-technical infrastructures which grant visitors new opportunities for encountering place through novel interactions on a personal level. In this project, these technologies have been shown to have the potential to highlight place elements whose place stakeholders feel are underappreciated, to subvert the limitations of top-down institutions, and to allow for the sharing of lived experiences within place. However, representing place through mobile learning technologies can present the same potential pitfalls as other mediums, particularly when it comes to authentic and complete representation. To combat these issues, I would recommend future work in this space investigate how technology designs can promote critical reflection and assessment in the creation and consumption processes of mobile learning technologies.

Figure 9.1 Students use OurPlace to record environmental readings from their high street during the Sense Explorers project.

9.1.2. Meaningfully Engage with Authentic Learning Contexts

In order to support authentic learning experiences, the intricacies and individual elements of each context must be taken into account. During his discussions of the issue of 'placelessness', Relph argues that the elements which make places distinct must be recognised and valued (Relph, 1976). He asserts that if we are overly concerned with designing efficient solutions which are interchangeable between different contexts, they cannot fully take advantage of the value of place. If these indistinct systems treat place as an anonymous, interchangeable factor, they can only offer 'inauthentic' experiences of place and risk normalising such experiences within society. It's possible to view OurPlace through this lens: the application acts as a generalisable tool, which can be applied in almost any context. It's also possible to make OurPlace Activities which do not relate specifically to any particular context: like other examples such as Khan Academy or Wikipedia, Frohberg would label these as 'context independent' learning experiences within the Task Model for Mobile Learning (Frohberg et al., 2009; Taylor et al., 2006).

However, I argue that it is not just the generic OurPlace toolkit itself which provides the learning experience: it is the Activities which are created using these tools, and these can offer a wide variety of relationships between the Activity creator, the learner and the technology

medium. For this reason, created Activites should be assessed by their own merits, separate from the application itself. For example, the easiest of Frohberg's other context types to implement through OurPlace is to have the learning activity have a *physical* contextual relationship with the learner: the Activity takes place in a space relevant to the learning topic, meaning it is authentically situated in physical space. Rather than simply have the learner passively absorb material, OurPlace also supports a degree of learner interactivity within this authentic space—Task Types such as *Location Hunt* react to the learner's physical location as an input method, whilst *Map Marking* Tasks can give the learner a degree of agency in that they themselves choose the locations of interest. An example of an Activity which is based in a physically authentic context would be the park volunteers' 'talking statue', which lectured the learner about the history of the learner's location, before guiding them around the park with *Location Hunt* Tasks. These Activities can also be configured to support a 'reconsideration' of places with which the learner already has a relationship: for example, the *Sense Explorers* OurPlace Activity asked students to reflect on the environmental factors of the areas surrounding their school (Figure 9.1). Doing this in familiar places contextualised the environmental issues the students encountered, removing a degree of abstraction and supporting a re-examination of place with new context.

Furthermore, OurPlace Activities can also take place in what Frohberg labels as an authentic 'social learning context': where learning occurs not just in authentic space, but authentic place—through the sharing of relationships with other community members and even entering communities of practice (Lave et al., 1991). This social learning context is often much more personal, with content being driven by the values of the context's stakeholders. Examples of this within the OurPlace studies include its use within the *Tyne Fresh* project and its use during the Travelling Showmen school trip. In both of these, the OurPlace Activity was used as a way to structure the school students' engagements with local stakeholders: promoting in-situ reflection not only in authentic space, but also through social engagements with local stakeholders—each of whom had values, knowledge or heritage to share. As such, I believe that OurPlace can be used as an effective tool for learning in multiple (independent, formalised, physical, social) learning contexts, and as shown in Chapter 7, seamlessly transition across these contexts when needed.

However, this obviously hinges entirely on the content created for the application—as suggested in Chapter 4 and evidenced in Chapter 8, without a strong contextual focus the technology itself can inadvertently become the learning objective, detracting from the learner's experience in place. As the technology itself doesn't have a meaningful relationship with the infrastructures of place, it can't supply the knowledge, values or social tensions needed for insightful learning experiences in space and place. This was somewhat alluded to during

the heritage workshop in Chapter 6, where one of the participants was disappointed that the Activities took the structure of a traditional school worksheet—a teaching method disliked by both Teacher 5 and Blumenfeld due to its detachment from real-world, authentic learning contexts (Blumenfeld et al., 1991). Without Activity creators contributing their knowledge or beliefs, OurPlace can only offer these shallow learning experiences. Because of this, I frequently struggled to create Activities which demonstrated the OurPlace app's capabilities in a meaningful way: I lacked the necessary passion, knowledge and stakeholder insights about the place at hand to create worthwhile Activities about them myself.

For these reasons, the creation of insightful content about the place in question is doubly important. Through the 'Community Historians' project, Fox and Le Dantec demonstrated the importance of involving and emphasising the agency and perspective of community members from the project's outset, as they were the ones best positioned to inform the final design (Fox and Le Dantec, 2014). With this in mind, they re-framed the community members, demonstrating their importance and agency within the research by referring to them as 'community historians' rather than 'participants'. The same can be said of utilising the knowledge, passions and agendas of local stakeholders for creating OurPlace Activities. However, the community historians were still collaborators who had been approached by the research team, rather than start a movement of their own inclination. The goal of OurPlace was to take this a step further, and provide a DIY solution to support stakeholders in creating place-based mobile learning activities as they saw fit, without the need for institutional support (including the research team).

By this metric, the success of some of the created Activities is debatable—very few groups created full Activities without any intervention on our part beyond sharing the app's existence (the lighthouse discussed in section A.3.2 being the main example), with a number of other groups seemingly stopping after creating Activities to test how the system worked. In order to promote meaningful engagement in authentic learning contexts, I recommend that designs for place-based, mobile learning technologies utilise the unique qualities of the spaces and places in which they operate. While engaging with the infrastructures and physical elements of space may be relatively simple, this project has shown that utilising place as a resource has been shown to be much more difficult. Doing so requires significant input from local stakeholders in order to take advantage of their knowledge and passions: creating content without them risks inauthentic representations of place, fewer opportunities for learners to engage with new communities of practice, or even a learning experience which concentrates more on the medium than the learning objective.

9.1.3. Provide Value to Stakeholders

Getting this input from local stakeholders is not a given—while simple OurPlace Activities can be made in mere minutes, the best ones are those which have been well thought out, thoroughly researched and even tested and iterated upon. As such, the production of these learning materials can require stakeholders to volunteer a significant amount of time, energy, and—if they are not particularly comfortable with digital technology—step outside of their comfort zone. For these reasons, it's become clear over the course of this project that this can not be a one-way contribution of resources: if they are to invest this effort, the stakeholders need to get something back out of their engagements with the technology.

The most obvious (and likely most commonly effective) of incentives is that of resources: OurPlace was seen as an appealing and viable option for many of the participants we engaged with, with it being free to use being a major contributing factor. As participants noted in the Heritage Forum workshop (Chapter 6), commissioning custom mobile applications can get extremely expensive. This is compounded by the fact that not only were the groups we engaged with frequently underfunded or entirely volunteer-driven, but simply having a mobile application doesn't mean that people will engage with it—at least, enough to justify the financial investment. As a result, OurPlace was seen as a low-risk option. While financial incentives are an obvious observation, it seemed to nevertheless be an influential factor.

One of the themes identified during this project was that granting both learners and stakeholders greater degrees of control over the content they produce can lead to a sense of ownership over it. This in turn seemed to galvanise the creators into sharing their content with others—for example, the 'talking statue' park volunteers immediately shared their Activity through as many channels as they could (including the local newspaper), and nearly all of the school groups had children showing their creations to both their peers and teachers alike. As with our engagements with community groups during the OurPlace project, Balestrini et al. note that their participants' high levels of engagement with CrowdMemo was likely largely due to the community's significant and pro-active involvement with the conception and running of engagements (Balestrini et al., 2014). This mirrors the use of OurPlace by many of the stakeholder groups, who often initiated any use of the app and had creative control over the Activities they produced. However, Balestrini et al. also note that a sense of ownership is not always enough to sustain engagement with a project over time, and argue that a sustained engagement with the participants was achieved by providing value to all of the involved stakeholders—with this value being provided in ways varying from simply respecting and valuing the participants' lived experiences, to providing opportunities for them to learn new skills. While not strictly a part of the technology, I believe that extensively working with and

within groups such as the Heritage Forum supported this process for OurPlace: it allowed the research team to identify ways in which we could provide value to the collaborators in return for their own contributions. The benefits of this kind of collaboration are also highlighted by Fox and Le Dantec, who found that configuring their research approach to be clearly and immediately advantageous to the community members greatly increased engagement (Fox and Le Dantec, 2014). The extent of this collaboration was demonstrated by the re-framing of participants to 'Community Historians', avoiding language which implied an unequal power dynamic between the community and the research team.

Another key consideration is if the technology is able to empower the stakeholders through the promotion of individual/group agency. I believe that this is another area where it is an advantage that OurPlace's Activity creation process is ran independently of any institutions or researchers: by this being a self-directed process, stakeholders are able to act as free agents, configuring their created Activities towards meeting their own requirements and supporting their own agendas. Previous HCI works have examined how other types of creative technologies which support 'Do It Yourself' approaches can promote individuals' agency (Chatting et al., 2017; Meissner et al., 2017). In their review of literature noting indicators of individual agency and empowerment, Ibrahim and Alkire describe agency as '*a kind of process freedom*', noting that other authors describe agency as being '*the ability of an individual to set [their] own goals and act upon them*', and that agency can support the acquisition of 'power resources': the assets which can be accumulated, invested and exchanged for 'power' (Ibrahim and Alkire, 2007). Rowlands defines power as being in four categories: power *over* other objects or people, describing the ability to manipulate or resist manipulation; power *to* do new things with new possibilities; power *with* a group acting with a common interest; and power *from within*, a measure of respect, growth and acceptance for oneself and others (Rowlands, 1997).

I argue that parallels can be drawn between these factors and the use of OurPlace within several of this project's studies. For example, the park volunteers were able to fulfil their goal of creating a 'talking statue' (as described in Chapter 6), (mostly) independent of the usual top-down institutional restrictions which would have affected their creative control and output. In this instance, I argue that Activity authorship acted as a power resource for the volunteers: it allowed them (power *with*) to create their own content as they saw fit (power *to*) and release it in their own timeframe, with a minimal need for top-down assistance from the local council (power *over*). The platform being open source (and therefore available for stakeholders with the knowledge and inclination to reconfigure to suit their own needs) also gave one heritage workshop attendee an opportunity to modify the application, allowing the reconfiguration of the software into a more suitable power resource. Arguably, instances

such as the art trail volunteer gaining enough confidence to procure and learn how to use their first smart device are also examples of power *from within*. In this regard, I believe that mobile learning technologies are able to empower users through content ownership, giving them a meaningful benefit to contributing time and energy towards content creation. In OurPlace, this was achieved by granting more creative control to users and elevating them from consumers to producers of educational content.

9.2. Responding to the Research Question and Objectives

At the outset of this document, I presented this research question as the main instigator for the research project:

> ***How can mobile learning technologies better surface and utilise the civic value of places and empower the communities which give them meaning?***

This question was then extrapolated into three more manageable research objectives, each with a more focused scope. I will now respond to each of these in turn, given the findings of this research project.

> ***Investigate how existing place and community infrastructures can be better utilised as resources for mobile learning.***

Through this project, I found that it was possible for mobile technologies to assist teachers in making use of existing infrastructure as learning resources. Furthermore, rather than just simply engaging with the surrounding *physical* resources, technologies such as OurPlace can be configured to support engagements with other, less tangible and immediately obvious qualities of place—the social elements such as heritage, politics and other relationships with local communities which turn spaces into places.

As suggested by previous research, this is best done through hosting learning activities within authentic physical and social learning contexts. While many mobile learning technologies successfully engage with physical contexts (i.e. the learning takes place in a space relevant to the learning topic—the learning is physically authentically situated), relatively few take full advantage of place as a learning resource by also engaging with its social context, in which learning occurs through forming relationships with others in place (e.g. engaging with communities of practice).

In this project, this was attempted in two ways: having the place stakeholders share their knowledge and outlooks through the creation of educational materials for others to experience and respond to; and, secondly, having the mobile learning component exist as a part of a larger learning project, giving students the time to research a place before using the technology within the authentic learning environment. This necessitated the inclusion of a seamless mobile learning technology, which would allow the learning experience to follow the learner across multiple contexts (e.g. classroom activities, then field trip, then follow-up classroom activities).

However, in many contexts this is easier said than done. For example, while many of the primary schools we engaged with were able to dedicate the time conducive to these more holistic styles of learning, the secondary schools were much more time limited, due to obligations to prepare students for quantitative assessments. For this reason, a framework to guide the use of mobile learning technologies within place-focused, project-based learning activities was developed—one which could be reconfigured in order to adapt to the contextual challenges of a given learning environment. While such adaptations will frequently result in compromises to the final learning experience, structuring such projects through the use of such a framework allows for outcomes to be more predictable and manageable.

Explore how mobile learning technologies can be designed to promote civic learning.

For the purposes of this research project, civic learning has been defined as being that which supplies the learner with the knowledge, skills and values they need to be citizens who actively participate in their local communities and take responsibility for understanding and improving them. This project has highlighted a number of ways in which civic learning can be promoted, with nearly all of them being related to supporting place-making: the process of forming relationships with space through having personal experiences with it, ergo forming place. Through developing a relationship with place, learners might be able to gain an appreciation of its value, potentially (as hoped by some of our volunteer groups) leading to a degree of stewardship.

We found multiple ways in which mobile learning technologies can be configured to promote place-making. One of the most important was to give learners a a greater degree of control over their learning activities. Not only did we find that students were more engaged with learning activities which involved greater degrees of creativity and decision making, but this greater degree of control also supports learners in gaining their own personal experiences with place—allowing them to form their own unique interpretations and relationships. Fur-

thermore, besides the obvious advantages of supporting learning being authentically situated in the relevant place, mobile technologies can also support in-situ reflection on top of simple data collection and absorption of knowledge. By supporting reflection in-place rather than it happening upon return to the classroom, the technology can be used to maximise the amount of the learning process that takes place within the authentic environment.

OurPlace also supported place-making by making it easier for learners to encounter other stakeholders' interpretations of place. Gaining additional perspectives on a place and awareness how different stakeholders' relationships with it differ could help learners gain a deeper understanding of a place's value. Furthermore, this functionality makes it possible for learners to be introduced to stakeholder communities of practice, offering further vectors for additional understanding and opportunities for active participation.

Explore how mobile learning technologies can be designed for the empowerment of place stakeholders.

I argue that a key way in which mobile learning technologies can empower local stakeholders is by acting as tools which stakeholders can use as a means to fulfil their own personal, place-based agendas. However, doing this effectively requires designers to both identify these agendas, and produce designs which will work effectively within a stakeholder's given context. As seen in existing research (Crivellaro et al., 2016; Fox and Le Dantec, 2014), spending time to work closely alongside place stakeholders can assist the research team in identifying their needs and agendas. In this project, having an active and co-productive relationship with stakeholder groups greatly assisted in the design process, as I was able to gain a greater understanding about the group's motivations, strengths and weaknesses, resulting in the development of a more suitable technology design.

For OurPlace, this meant designing a technology which emphasised stakeholder agency. During these studies, stakeholders were able to create their own bespoke, interactive mobile learning activities, independent from the top-down institutions (such as local government) upon which they are normally reliant. In this regard, OurPlace was able to empower these stakeholders in sharing their knowledge and agendas by giving them a means of production within their own control, without the need for technical knowledge or significant funding. I argue that for these volunteer stakeholders, the ability to create their own mobile learning activities acted as a power resource: it allowed them to create their own content as they saw fit and release it in their own time-frame, with a minimal need for top-down assistance from the local council. This can also be seen in other Digital Civics-related projects, such as PosterVote (Vlachokyriakos et al., 2014) and AppMovement (Garbett et al., 2016). In line with

these examples and the findings of this project, I would recommend that designers looking to empower place stakeholders through mobile technologies explore how such technologies could support stakeholders in attaining greater degrees of agency in fulfilling their own needs and agendas.

9.3. Project Limitations and Future Work

While this project involved engaging with dozens of stakeholder groups and hundreds of school children, the work still faced a number of limitations which could be explored in future work. This section will address the project's most major limiting factors.

Measuring Learning and Curriculum Integration

One of the choices made from the project's inception was that we would not take measurements of learning outcomes. While this might seem strange (OurPlace is, after all, a tool for creating and consuming learning resources), the subject of assessing students' learning is large enough that it would have taken up a significant portion of this document and research time. As this is such a huge topic, a significant body of work already exists investigating the quantitative and qualitative benefits of outdoor learning, technology-enhanced learning and project-based learning pedagogies. Rather than measure knowledge before and after the use of the platform and include control groups, I decided to trust the teachers' judgements in how each engagement went—how the students performed, how well they engaged with the learning activities and how well the application integrated into the teaching environment. This seemed like the optimal choice, as the teachers had an extensive understanding of the students' past performances, as well as a thorough understanding and experience with teaching and assessing for various pedagogies. In this regard I positioned myself as a layperson, supporting the teachers in using the OurPlace platform in ways they saw fit, and enquiring about their opinions during and after each study.

As denoted by the project's design goals, rather than directly influence learning outcomes by itself, I designed OurPlace to support a variety of types of engagement and learning (i.e. authentic, situated, seamless, project-based) that have been previously shown to increase the probabilities of learning happening (Blumenfeld et al., 1991; Frohberg et al., 2009; Sharples, 2013). As such, OurPlace's evaluation was based on demonstrating that these types of engagements happened, rather than measuring students' academic achievement. As such, by promoting these engagements, I argue that OurPlace increased the probability of meaningful

learning occurring. Such an approach has been taken by previous researchers (e.g. Kharrufa (2010)) who have focused on less easily quantifiable—but still recognised and valued—skills such as critical thinking, meta-cognition and reflective thinking. Similarly, this project was largely focused on growing an awareness of the value of place, and the communities, heritage and environment that form together to make it. This placed a significant focus on holistic approaches to learning, which tend to run counter to quantitative measurements and formal examinations due to their focus on emotional development, social skills and critical thinking, rather than simple fact-based and rote learning. Measuring the outcomes of such learning processes tends to be less concrete, and so this was approached through observation and conversation, rather than formal examination.

That said, not every school can follow this type of learning approach—either due to teaching preferences or institutional pressures. For example, School 3 was particularly focused on 'teaching to the test'—secondary schools are particularly pressured to perform well during exams, leading to a very narrow curriculum focus. This leaves little room for holistic teaching approaches, as methods which don't require learners to remember facts related to examination criteria are often perceived as being 'risky'. We struggled to get many other secondary schools to take part in the project for this reason, and those which did, such as School 2, were only for very short periods of time. This severely limits the amount of meaningful engagement that the students can have with either the technology, subject matter, or both—the lack of time resources available to the teacher would require significant compromises in PBML-like activities (see Figure 8.6 for an illustration of compromises). For example, the *Journey Through Tyne* project provided excellent opportunities for students to gain a holistic understanding of the subject matter, but the lack of classroom preparation time meant that the integration of technology was extremely shallow.

There exists an opportunity for future work to further explore how project-based mobile learning can be more deeply integrated into existing curricula, supporting elements such as formal assessments for schools which require them. I believe it's only by trying to accommodate for these requirements that we can gain meaningful insights into how PBML can fit into the practices of wider school systems.

Varying Learning and Stakeholder Domains

While this project engaged with a large number of schools and community stakeholders, these studies largely concentrated of the learning domain of local history and heritage. I believe that place and project-based mobile learning has the potential to be used in a wide

variety of learning domains, with place and community infrastructure used as rich learning resources. Examples of these other domains could include: music, where schools were able to utilise local expertise to enrich their music lessons as seen in Remix Portal (Dodds et al., 2017); politics, with students investing the impact of policy upon their area by collecting various stakeholder views, à la Community Conversational (Johnson et al., 2017); and the sciences, exploring topics such as the impact of climate change and pollution upon the community's health in a manner similar to Sense Explorers (discussed in Chapter 7). There are clearly a wide number of potential application areas for PBML still to be explored.

However, while the PBML framework is tool agnostic and should be largely suitable for these different knowledge domains, it is unlikely that the same technologies that worked well the context of local heritage would perform as well when applied to others. For example, in its current form, OurPlace would likely not be an effective tool for learning music production beyond its capacity for data collection in the Research stage. If new mobile technologies need to be developed for use within these contexts, it is likely that the researchers would benefit from a process similar to what was undertaken with this project—meeting, spending time with and forming relationships with multiple relevant stakeholders (e.g. teachers, local musicians) to gain a better understanding of their needs. This process needs to be particularly thorough if it is to account for stakeholders' variations in perceptions of place—as Tuan argues, because a person's place attachment is formed based upon individual experience, peoples' perceptions of place may not align with each other, running the risk of inappropriate design decisions if not handled with care (Tuan, 1978).

Avoiding Inadvertently Supporting Austerity Measures

As discussed, this project took place as a part of the Digital Civics agenda, set against a backdrop of economic austerity enforced by Conservative politics. I maintain that the goal of Digital Civics is to strengthen relationships between citizens and local service providers, by empowering citizens to have more involvement and agency within their government's processes. However, this doesn't mean that technologies designed and created for this purpose can't be misappropriated and used to justify austerity measures, through cost reduction and automation. Unfortunately, the possibility for OurPlace to be misused was highlighted in the 'Places in Transition' study, where the participant institutions saw value in the app as it was more economically viable than human tour guides. I don't believe that there were other instances during these studies where the app could be argued to have been used as a tool to support 'down-sizing' (in fact, OurPlace technically created a job with the Community Railway Partnership), but it was concerning none-the-less. I would like to see future Digital

Civics projects to critically explore how (or if) these new processes and technologies can be designed to mitigate hardships inflicted by austerity measures in a way which can't also be used to legitimise them.

Interventionism and Replicability

As Dourish notes, the role of the researcher within long-term engagements with stakeholders (e.g. through ethnography) necessitates more than logging data: there is a degree of individual interpretation on top of simple observation (Dourish, 2006). As a result, he argues that the findings of ethnographic studies often implicitly reflect the researcher. Likewise, design-based research requires a degree of interventionism on the part of the researcher, in order to follow a pro-active research agenda. It is highly unlikely that the events reported in this study would have happened without my numerous interventions—examples include how I supported the existence of many of the deployments through supplying classes with Android tablets; how I assisted park volunteers with creating their Talking Statue in the ParkLearn app; how I introduced the PBML framework to the teachers and ran numerous sessions; and how Open Lab supported the Travelling Showmen study by paying for transportation from School 5 to the fair. These interventions took place in naturalistic research contexts and were largely successful, but they did not naturally occur. This is an important distinction, impacting some contexts more than others: it's unlikely that the tiny School 4 could have afforded to buy a dozen Android tablets, for example.

Furthermore, the context-focused nature of design-based research means that many of the conditions and findings in this study would be hard for other researchers to accurately replicate. It is highly unlikely, for example, that a peer would be able to find teachers and schools existing in the same socio-economic, professional and political context, along with classes who shared the same attitudes to learning as those found in this project. As such, many of the specific findings are not particularly generalisable, and nor should they be: they are wrapped up in individuals' interpretations and relationships with the places and communities around them. Removing this context from the findings would simultaneously remove much of their intrinsic value. Instead (as discussed in Section 1.3), this thesis has attempted to present, develop and test theory, supporting its use in other works through rich accounting of the interventions and engaged contexts to support transparency and an understanding of *why* results occurred—not just *what* occurred. I hope that this has been successful.

9.4. Conclusion

The primary goal of this research was to explore if and how mobile learning technologies could be used to surface the value bestowed upon local places by the communities which give them meaning: both for the purpose of education, and for the empowerment of those communities through the platforming of their values and agendas. Through holding a number of longitudinal and short-term case studies with teachers, students and community stakeholders, this project identified and explored the design space for mobile learning technologies which harness local, place-based resources (both social and physical) to support educational activities and the sharing of local knowledge and values.

Having identified the design space for the use of public places as infrastructure for civic mobile learning, I designed and developed 'OurPlace' to aid in its exploration. OurPlace is a seamless mobile learning application which supports the grassroots creation, sharing and completion of interactive, place-based mobile learning content. Through a design-based research approach, OurPlace was deployed and evaluated in authentic usage contexts, including a wide variety of schools and a number of local volunteer-based heritage groups. Varying between one-off studies and collaborative relationships which ran over multiple years, these engagements informed the evolution of OurPlace from a prototype application to a platform which has been adopted by external stakeholders.

These engagements highlighted that mobile technologies could not only be used to make use of physical local spaces as learning resources, but that the socioeconomic infrastructures of *place* could also be utilised to offer learners rich insights into what gives those spaces meaning to local communities. This project found that mobile learning technologies could support learners in building relationships with place, by giving local stakeholders opportunities to share their knowledge and values and supporting learners in exploring these interpretations and concepts within authentic learning environments. I also argue that mobile learning technologies such as OurPlace can empower local stakeholders by acting as tools through which they can fulfil their own personal, place-based agendas—without needing top-down support from larger institutions, which may have their own conflicting interests.

To further explore how these findings could effectively be put into practice within formal education contexts, I introduced a framework for 'Project Based Mobile Learning': a framework for a series of educational activities which engage with local place, and result in the production of student-created mobile learning content. This framework was developed over the course of a number of school engagements through a design-based research approach, and required adaptation to each school's unique contextual restraints. I demonstrated how

through this framework, OurPlace and other mobile learning technologies could be used to support place-based learning through project-based pedagogies within formal education contexts, but also that any adjustments made to the framework to accommodate for contextual requirements will result in trade-offs which may impact its effectiveness in predictable ways.

These explorations have also raised new avenues for investigation in future research. In order for a wider variety of schools to benefit from these findings, further work needs to explore how project-based mobile learning can be more deeply integrated into existing curricula, supporting required elements such as formal assessments. Furthermore, in order to combat the spread of incorrect (or incomplete) information, I would recommend future work in this space investigate how technology designs can promote critical reflection and assessment in the creation and consumption of mobile learning content. Finally, I would like to see future projects critically explore how technologies such as OurPlace, which are designed to mitigate hardships inflicted by austerity measures, can be misused in ways which reinforce and legitimise them, and how such scenarios can be avoided.

Appendix A. Documents

A.1. Information Sheets

The following is representative of the content on information sheets given to participants. The content varied slightly with each study, according to the purposes and processes of the study, as well as if consent was needed from an adult participant or by the guardian of a participating child. The contents below have been edited to maintain anonymity.

Dear Sir/Madam,

We would like to invite your child or a child you care for to participate in a research project, OurPlace, being run by Open Lab, Newcastle University.

What is this study about?

The aim of the research is to explore how digital technologies can support the use of local heritage sites and their surrounding communities as an infrastructure for learning. Encouraging outdoor learning within schools has become a high priority for Ofsted and these sites and communities are often overlooked as teaching resources. Many of these sites – such as parks – have also seen severe budget cuts over the last several years, and through projects like this we hope to increase their perceived value within local communities.

We are developing a mobile application – OurPlace – which supports the creation and use of playful learning activities in these locations, for use by teachers, families and local community experts.

What would participation involve?

This session will involve children and their teachers and assistants using the OurPlace mobile application in [redacted]. This will take place during a normal visit to the park, meaning no additional teaching time will be taken up by the research.

The children will be asked to complete various activities using the app. These activities have been created by teachers from the school, and have been designed to take advantage of the park environment as a learning resource. Using the app, children may be asked to take photos, record video, draw pictures and plot locations on maps. The materials that the children create can later be used in follow-up classroom activities. The children's usage and impressions of the application will be used to assess it and shape its development going forward. These impressions may be audio recorded and transcribed for later reference.

Attached is a consent form, with multiple elements for you to confirm. If you are not comfortable with any of them, feel free to not tick them. The researchers will not take photos of your child without your consent, nor will they collect any information that could be used to identify them. Any images which the children take will be accessible by their teacher.

What happens if I change my mind during the study?

It is up to you whether you want your child to take part. You can choose to withdraw your child at any time if you no longer wish for him or her to take part, even after the study has finished.

Confidentiality

All of the data items collected, including photos, audio recordings and transcripts, will be anonymised and stored securely. Only members of the research team will have access to them. Our findings will be published in written reports that will not identify your child or show that they have taken part. If photos taken by the researchers or by children using the application show other children, we will blur out their faces when used in publications or publicity material.

We would be grateful if you could complete the attached consent form and return it to your child's teacher prior to the school trip.

Thank you for your time and consideration.

Sincerely,

Dan and Ahmed

Contact Details:

Dan Richardson: d.richardson@newcastle.ac.uk

Ahmed Kharrufa (Supervisor): ahmed.kharrufa@newcastle.ac.uk

A.2. Consent Forms

The following is representative of the content on consent forms given to participants. The content varied slightly with each study, according to if consent was needed from an adult participant or by the guardian of a participating child.

Parents' Consent Form – OurPlace

	Please tick if you agree
I have had the purpose of this study explained to me.	
I have had the opportunity to ask questions about the project and my child's participation.	
I understand that my child does not have to take part. His/her participation is voluntary and can withdraw from this study at any time.	
I allow the researchers to take photographs of my child partaking in the study. I understand that any photographs of participants will be stored securely, and will be censored of any identifiable features if published.	
I agree to audio recordings being made of my child's impressions of the application. I understand that these recordings will be transcribed, and any personal details will be removed.	
I agree to the use of unnamed quotes in future publications of this work and I understand that any subsequent publication of this research will not identify my child or me by name.	
I understand that I can contact the researchers at any time and I have been told how to do this.	
I understand that any personal data that my child and I provide will be retained and processed by the researcher in accordance with the General Data Protection Regulation (GDPR, 2018).	
I consent to my child's participation in this study.	

Name (Participant) _____

Signed (Parent/Guardian) _____

Signed (Researcher) _____ Date _____

A.3. Additional Community OurPlace Engagements

Discussion of these studies was cut from the main document, however I believe them worthy of inclusion here as they either informed changes to the OurPlace application, added to my understanding of the stakeholders who wanted to use it, or provided examples of real-world use cases of the application.

A.3.1. Railway Museum

Designed to transport coals from the region's pits, this site features one of the world's earliest modern railways. As well as the railway lines and several restored locomotives, it boasts a small museum, with a gift shop and tearoom, ran largely by volunteers. One of the site's staff (HP1) was a Heritage Forum member, and wanted to create a walking trail around the site using the OurPlace app.

Initially, HP1 wanted to create a 'premium' OurPlace Activity to coincide with a major regional event, which was expected to attract a large number of tourists into the area. The museum had been given access to some funding to take part in the event, and they wished to commission the creation of premium assets to be used in an OurPlace trail. This included audio interviews from local stakeholders, photos from the site and cartoons relating to the site's history. However, HP1 seemed to have a misunderstanding of how the app actually worked: rather than Activities being structured sets of Tasks into which you put content, they thought it was something more akin to a fully customisable website, where creators could change how the app looked and behaved. This confusion, which seemed to stem from the participant's lack of experience with the app and low technical literacy, resulted in the Activity not being made in time for the event.

However, once this confusion had been cleared up, HP1 realised that creating OurPlace content was also less technically demanding than they had originally thought. As they were still uncomfortable with creating an Activity independently, I agreed to assist in making it with them on their iPad device. This resulted in a digitised version of a previously existing trail, using *Location Hunt* Tasks to guide the user between points of interest. Each point of interest had an *Information* Task associated with it, featuring some written information about the location's history and some historical photos. The Activity was made public, and made available to launch from QR codes within the site's museum or by its association with the site's location in the OurPlace app.

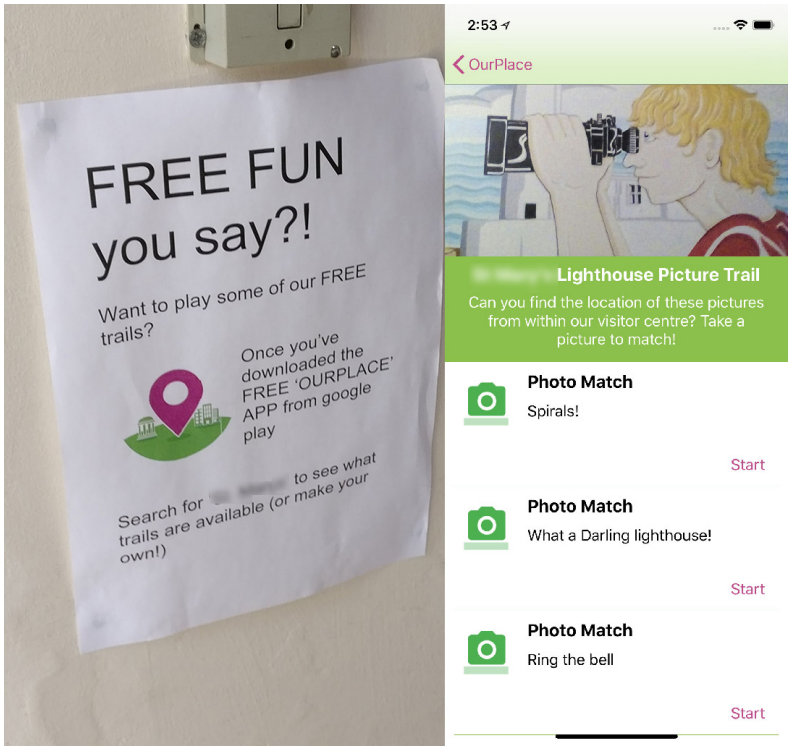

Figure A.1 The management of a lighthouse visitor centre advertise their OurPlace Activity, and invite visitors to make their own.

A.3.2. Lighthouse

Operated by the local Council, this lighthouse is a local tourist attraction, offering a gift shop, nature reserve and paid entry into the lighthouse itself. This Activity's existence was a particular surprise, as I found it by coincidence while visiting the lighthouse. Having attended the heritage workshop, the lighthouse's staff had soon afterwards independently downloaded OurPlace and created their own Activity for visitors to use. Rather than focus on the lighthouse's history, the creators seemed to be more interested in creating an entertaining activity for visitors: consisting entirely of *Photo Match* Tasks, this Activity simply challenged its users to explore the lighthouse, and find particular features within the space.

The Activity's creators went as far as to create their own poster, advertising the existence of the Activity and featuring the OurPlace branding (Figure A.1). However, they clearly misinterpreted the app's Activity discovery system: the poster tells users to search for the lighthouse's name, rather than the Activity's share code. The creator also either didn't know about the QR code scanning feature or the app's website, as the poster also doesn't feature the Activity's QR code.

One interesting thing to note is the poster's call to action, suggesting that visitors create their own Activities around the lighthouse. While some other groups had been hesitant about the idea of anyone being able to create Activities in their space, the lighthouse creator seemed to welcome public contributions and collaboration.

A.3.3. Community Railway Partnership

Another member of the Heritage Forum (HP4) got in touch to enquire about their potential use of OurPlace within their group's educational activities. HP3 was an officer in a 'community rail partnership' (CRP) group—a not for profit company that works with train operating companies to 'promote, strengthen and protect' the role of a particular railway line in the North of England. The group aims to increase public awareness of the rail services, increase community involvement in the rail lines and strengthen links between the railway industry and the communities and businesses it serves.

HP4 arranged to meet me at Open Lab, along with the CRP's Company Secretary and their Director of Finance, as well as the Community and Sustainability Manager for the railway line's train operating company (HP4 invited this person as they wanted them '*to see that OurPlace could be a great community engagement tool for the Community Rail Partnerships in the North East*', but unfortunately they could not attend the meeting). The group were interested in how they could use mobile learning as a part of their delivery of educational activities on and around the railway. During the meeting I gave a demonstration of the OurPlace app by showing some example Activities (made by both adult stakeholders and school students, covered in Chapter 8), and the process of creating new ones. When conversation moved onto how children themselves could create Activities as a part of the educational events, I also demonstrated the jigsaw activity for creating paper prototypes of OurPlace Activities.

The group brainstormed several ideas about how they could use the OurPlace application to deliver engagements. Ideas included: i) creating Activities in the app which could be completed by visitors and children, both during train journeys and about particular stations (e.g. related to the history of stations and the railway—how they had been used, and how communities had formed around them); ii) children researching these and other subjects, and then creating their own Activities to share with peers and other railway users; iii) using OurPlace Activities as engagement platforms, through which communities could use different Task Types (e.g. *Take a Photo*, *Map Marking*) to engage with the CRP staff—e.g. providing evidence of volunteer work, or report issues with facilities.

By the end of the meeting, the CRP group had decided that they wanted to use OurPlace as a major part of their engagement programme. The final portion of the meeting was consisted of them discussing the practicalities of what was needed to do so. For example, HP4 saw value in the jigsaw activity as a process for designing Activities (particularly with school groups), and was curious about how they could be made (to the extent that they asked if they could order kits for purchase from Open Lab). The other main considerations were device availability (tablets would have to be bought for the purpose of running OurPlace engagements), and the need to have staff who were i) trained in the use of the OurPlace platform ii) able to dedicate time to design, create and deliver educational sessions which made use of the application.

The group decided that they would apply for a number of grants from the train operating company, both in order to cover the costs of purchasing a number of tablets and to finance a member of staff who would be dedicated to designing and delivering OurPlace engagements for the CRP. At the time of writing, £17,000 of funding has been secured for this, with the CRP having received the funds and starting the process of advertising the role. Unfortunately, this has also been delayed by the coronavirus epidemic.

A.3.4. Modern Art Trail

I was contacted by a retired art teacher (HP2), who had recently started volunteering to run tours of the modern art pieces installed in a local park. They had found out about OurPlace through the Talking Statue installation, and wanted to know how suitable the app would be for use as part of their art trail. After discussing the app and going around the trail, HP2 decided to go ahead with creating an Activity. However, as they didn't own a smartphone and weren't very comfortable with using digital technologies independently, they arranged a follow-up meeting for other members of the park's *Friends* group to attend.

This meeting took place in a function room in one of the park's main buildings. To assist the group in designing the OurPlace Activity, I took along a jigsaw kit (described in Section 4.2.4) so that they could start designing a paper prototype of the Activity without having to be completely comfortable with the digital interface. After a brief demonstration of the app, the participants started outlining and discussing an Activity using the jigsaw and HP2's notes about the different art pieces, which included blurbs about the artists and the reported meanings of the pieces themselves.

Rather than be a simple trail which passively delivers information at each stop, the group were interested in how they could use the different functions of the app to enhance the visitor's experiences with the artwork. For example, suggested Tasks included challenging the user

Figure A.2 Users of the art trail Activity were challenged to catch the sun's light through this glass poppy, and reflect on how the piece would be altered by different light conditions.

Figure A.3 The homemade version of the jigsaw Task Type pieces, created by a member of the park's *Friends* group to assist in designing Activities in the park.

to *Take a Photo* of the sun's light passing through the glass of a particular sculpture (Figure A.2), and then *Record Audio* reflecting on how they think the mood of the piece might change in a different light. Because the trail was becoming so generative, the participants became interested in how they could use people's uploaded responses: ideas included featuring them on the *Friends* group's website, and creating collages of the uploaded images. Because of this, the group were keen on creating the Activity on their own devices, so that they could view authorised responses on the website. They were also concerned about the privacy settings for those who responded, but were satisfied with how the app handles privacy settings once they were clarified.

Rather than create the Activity there and then, the group decided that they wanted to take their time designing the Activity over several sessions, and were happy to do so independently. They claimed to find the jigsaw extremely helpful, and borrowed it to use in their design sessions. Having been able to get used to the structure of the app's Activities through the jigsaw, HP2 now felt more comfortable with the idea of engaging with the technology, and ordered their first smartphone so that they could work on the Activity at home.

Despite this added confidence, they still ran into a couple of issues with the application and asked for help through a follow-up meeting (it turned out they had mixed up the *Record Audio* and *Listen to Audio* Task Types, and were confused as to how they could add audio files while creating *Record Audio* Tasks). During this meeting, one of the members (HP3) revealed that they had created their own Task Type tokens by printing out images of the jigsaw pieces onto foamex board (Figure A.3), and had been using them to further help them keep track of what Tasks they were creating for each Activity. While we created an Activity together on one of their own phones, HP3 laid these tokens out during the planning stage, and then flipped them over as the Tasks were created. In this way, the tokens acted as a simpler version of the jigsaw, as they didn't require the planning of the Task descriptions.

During this follow-up meeting, HP3 also noted that they had decided to create two versions of their trail: one for the visitors who would normally consider going on the trail anyway, and another version designed for use with schools. While the first one would largely be a digitised version of the existing trail's format, focused on the delivery of information (with some added interactions to stimulate reflection on the art pieces), the version designed for schools would make use of the seamless nature of the OurPlace application. This version would focus on the more creative and generative Task Types, with the explicit intention for students to generate materials and record their reflections in-situ for later use upon return to the classroom. When I enquired what had inspired them to use the app in this way, HP3 revealed that they had printed and been thoroughly (with the liberal use of highlighter) reading one of the project's

resulting publications (Richardson et al., 2018) of their own volition. Unfortunately this study was interrupted from progressing further by the COVID-19 epidemic, and the trail has not been completed as of the time of writing.

A.3.5. Heritage Forum Conference, OurPlace Workshop

I also held a short workshop at the Heritage Forum's conference the following year. This workshop consisted of a short presentation introducing the project, and then an interactive section in which participants were able to try out the OurPlace app for themselves. Following a tour from the conference venue's manager, I pre-prepared an Activity about the building and loaded it onto the available tablets. The Activity was designed to show how the app could be used both as a form of digital interpretation and as way to provide visitors with a more interactive experience. As the Activity was limited to being inside the venue, I chose not to use *Location Hunt* Tasks. Instead, the Activity guided the participants around to different areas of the building to find various QR codes, which when scanned revealed information about its heritage and various interactions as Follow-Up Tasks.

While short, this workshop highlighted how varied the levels of digital literacy can be, even amongst people of similar demographics. For example, a representative from one heritage group was interested in if they could run their own version of the OurPlace server, offline on their local network—their site was a cave system, and didn't have access to the Internet. This person clearly had technical knowledge, as they were asking about how they could use the open-source nature of OurPlace to make it more suitable to their own circumstances. However, in the same workshop were multiple individuals who had never used an app, or seemingly even held a smart device before. It was clear that I had over-estimated the base technical literacy of the participant group, as this person was asking me to explain what a smartphone app was—while the app's documentation had explained some basic information for non-technical users (e.g. how to download the app from Google Play), it was within with an assumed base level of knowledge about the *existence* of the technologies and interface metaphors the app is built upon. Accommodating both of these potential audiences was extremely difficult in the workshop, but it was clear that the many of audiences that the app was targeting (i.e. heritage enthusiasts, institutions and volunteer groups) would also be comprised of individuals with a similar mix of degrees of comfort when dealing with technology.

A.4. Additional Teacher engagement: Petting Zoo Trip

Discussion of this study was cut from the main document, however I believe it still worthy of inclusion here as it informed changes to the OurPlace application

Shortly after the first trip with Teacher 1, I led a one-off engagement with a different school's reception class (N=28, ages 4-5) and their teacher. While the previously discussed study was primarily investigating how the approaches taken by the teachers towards the application changed over time, this one was much more focused on immediate results: exploring new ways of using the ParkLearn platform, observations of interactions with the different Task Types, and testing it for bugs.

Following the same methodology as the initial engagements with Teachers 1 and 2, the teacher was introduced to the application separate to the class during an hour-long meeting, using example Activities to demonstrate the app's functionality. The latter half of the meeting consisted of the teacher creating an Activity for the class's trip to a park and petting zoo the following week. This Activity consisted of 5 different Tasks and Task Types: 'What minibeasts can you find?' (*Take Photos*), 'Draw what you can see from the bridge!' (*Draw a Picture*), 'Can you find the petting zoo?' (*Location Hunt*), 'Record your favourite animal that you can see!' (*Record Video*), 'Record your friend making their favorite animal noise!' (*Record Audio*). As this school was reliant on me for access to tablets, this limited the number of devices to twenty between the students—meaning several children had to share one between two. My observations and the verbal impressions from the children made during the trip were recorded as field notes. The practical nature of these notes meant they could directly inform the development of the application, without needing to undergo thematic analysis.

In total, the children created and uploaded 19 responses to the Activity, consisting of 106 photos, 12 drawings, 14 videos and 8 audio recordings. Despite being extremely young, the children proved to be able to use the application effectively, especially when completing camera-based Tasks. They particularly enjoyed the *Location Hunt* Task Type, thanks to both the audiovisual component of the increasing speed of the animation and beeping, and the exciting ambiguity of not knowing exactly where the Task will take them. However, there were some elements of this early version of ParkLearn which frustrated the children. For example, this version only allowed one drawing, video, or audio recording to be made in response to a Task—if another one was produced, the first would be overwritten. This decision had been made with the intention of simplifying the interface (not having multiple responses listed for each Task) and reducing the amount of storage and bandwidth required when uploading responses. However, during this study it led to children overwriting their work by accident, or

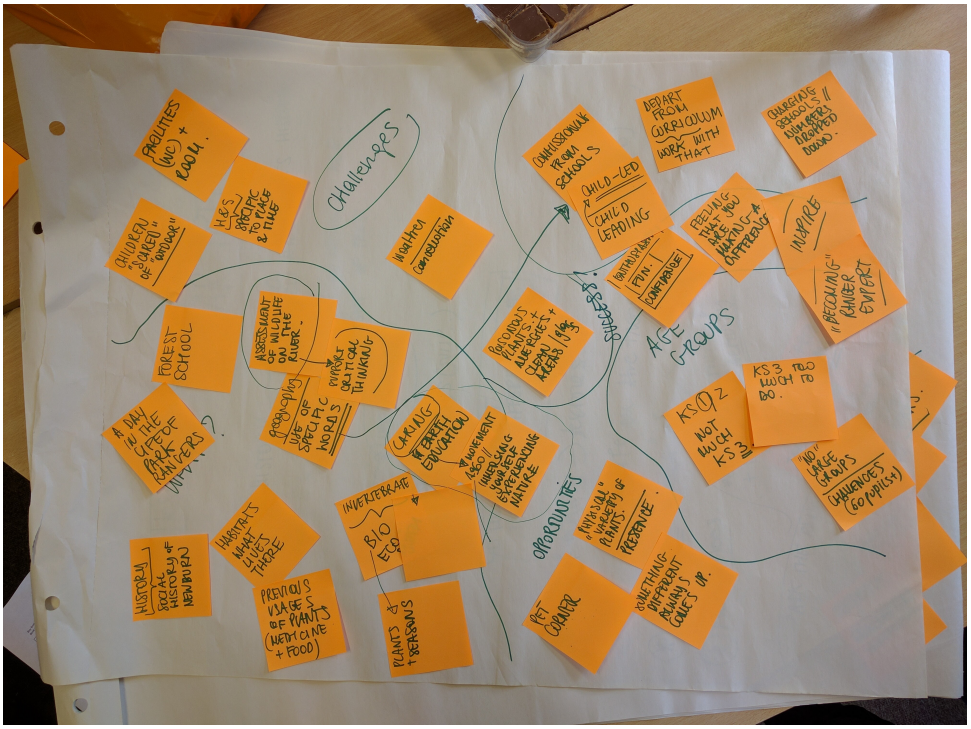

Figure A.4 Example results of a theme triangulation session with Dr Clara Crivellaro

being frustrated at not being able to produce multiple responses to a given Task. As a result, later versions of the application introduced the ability to produce multiple pieces of media to a given Task.

A.5. Thematic Analysis Example

The following is an anonymised example of the contents of a Word document featuring the codes and resulting themes developed from printed transcripts, following the process discussed in section 1.3.2. This particular document is the final result of the codes generated from the transcripts of the engagements described in chapter 8. Due to space limitations, the entire transcripts cannot be included. Themes are presented in bold, with each theme's codes then presented in italics, and anonymised pertinent quotes and observations for that code included in regular text.

Students' Desire for Independence

Children eager to contribute, have responsibility, grow up

- [researcher] “The children help out a lot then. So if you guys were show children, you’d be helping work. Does that sound good? Would you want to be working?”
- [children] “Yes!”
- [researcher] “Why would you want to be working?”
- [child1] “To get money to support my family”
- [researcher] “To get money, help your family get money yeah.”
- [child2] “To provide for your family and buy a house and if you have some money left over to buy a car”

- [child7] “If you’re doing the same as your family, if you’re a child you might not get paid as much because people could want to only go to adults and think that children are not responsible yet.”

Doesn’t want to be restrained by an inherited job

- [child1] “The reason that I wouldn’t like a job like your parents is that for example, at the hoppings you just go around selling for a pound and stuff, and you only get a pound. For example, say if I was an engineer, I would get for example 20 or 10 pound. It’s more, I get paid more. If I did the same as them, I wouldn’t want to do that - wait around, and maybe they wouldn’t even come, have a ride. It’s like more better, more educational for you. Saying, ‘You want a ride?’ is not really, like useful for people. Being a mechanic is more hard, and if you just carried on a tradition you might not really like it, like what they’re doing.”

- [researcher] “Would anyone here be unhappy if they had to do what their parents did? Does anyone want to do something different to their parents?”
- [children] “Yeah”
- [child8] “It’s just natural”
- [child2] “It’s natural to do something different”
- [researcher] “That might not be true, you get people who do the same jobs as their parents and pass it down for generations”

- [child9] “I don’t want to do my parents’ job”
- [child10] “I don’t want to do my parents’ job because my Mam doesn’t work and my Dad works as a builder”

Children’s prepped questions for showchildren focusing on them earning money and their role/impact

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- [child2] “How much do they make in a week?”
- [child14] “How much money do you earn?”
- [child18] “How much money do you make in a year”
- [child20] “What’s your net worth”
- [child21] “Do you enjoy it and do you get enough money?
- [child27] “Have you ever designed a ride”
- [child28] “Have you ever chosen a ride to build”
- [child1] “I would ask them their age, then I would ask an eleven year old, have you made something yet. And I would ask a seven year old, have you made a little model.”

Expectations of financial knowledge, independence and respect within the family

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- [researcher] “Do you think the kids would know what? Do you think they would know how much money is coming in for the family?”
- [children] “Yeah”
- [researcher] “Why do you think that? How do you think they’d know?”
- [child1] “They’re good at maths”
- [child2] “Their grandparents would tell them”

Students earned independence, teachers’ trust, through maturity

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- [teacher] "What I enjoyed was trusting you to work with Dan and Georgina, because that means you're really Year 4s, doesn't it? That we can trust you to do something, away from the class teacher and still do something really, really good. So well done."

- [teacher2] "I would like to also point out how good they were as teachers, as well. They really came into their own. The Year 4s were outstanding, very good, and I was very proud of them."
- [teacher] "I think you really are stepping up to be Year 4s, it's wonderful to see. Well done all of you, that was brilliant. And if you're very grown up, you get to do very grown up things. So let's give year 4 a clap."

Positive Outcomes of Students' Independence

Teachers capitalising on students' independence

- [teacher2] "That's why you give them very simple things. But they don't have to do all of these things"
- [teacher1] "Oh no, I just want to know what-"
- [teacher2] "The groups will decide what best fits their thing"
- [teacher1] "Absolutely. I just want to know what is available."

- [teacher2] "The kids are much better at thinking of ways they can adapt what they've found to other things."

- [teacher2] "It would be quite nice for them all to make a section to collaborate. Then each group can come up with their own activities, and then put it together a nice big, meaty thing at the end, a tour of Gosforth."

Creating activities involves asking questions -> independently searching for answers

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- [child1] “We are going to find Newcastle Castle’s roof...and do lots of activities. First, I’m going to ask them to find out when it was made.”
- [researcher] “Oh that’s a good question, isn’t it. Do you know the answer?”
- [child1] “No. But I can search it up on Google”

Desire for access outside of school

- [child1] “Is this app available on any type of tablet, iPad?”
- [researcher] “Yeah, you can download it at home if you want to”
- [child1] “I tried, it didn’t work”
- [researcher] “Did you try recently?”
- [child1] “No”
- [researcher] “If you try again it might, because I did fix something”

- [child1] “Wait... what app is this on?”
- [researcher] “It’s called OurPlace, it’s one that I made”
- [child1] “Can you get it on iPads?”
- [researcher] “Yep”
- [child1] “Ah! Can I get the app?”
- [researcher] “Yeah, it’s free”
- [child1] “Yay!”

Tools were generalisable enough to facilitate and capitalise upon students’ varied ideas and approaches

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- [teacher2] "They were very different as well weren’t they? The ideas. Even though you all started off with the same tools."
- [teacher] "Well that’s what’s great–that everybody’s had their own ideas"

Observation: Used OurPlace as a platform for their own jokes/memes (Celebrate Good Times, prequel memes), putting these to use constructively within school projects

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Lack of Scaffolding Leading to Focus on Tech over Content

Left to their own devices without much scaffolding/guidance, Y8 students created very general/vague activities

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- [researcher] "In terms of making it useful for a trail... 'an area of interest' is very general, isn't it?"
- [student] "Yeah, I guess. So instead of saying 'an area of interest', give something more specific?"

- [teacher] "It might have all the bells and whistles, but if you're not learning anything it's pointless."

- [student2] "I think we've found it easier than other groups because we focussed more on the content than using all of the different interactions. So a lot of the content can be the same [as the analogue version], it's just changing how to interact with it"

- [teacher] "it seems to me that some of you have got the basics of the technology, I think. I think that there's some good stuff technology-wise. I think what needs some further thought, is what you're actually asking them to do in terms of the content."

- [teacher] "You'll learn from that experience though, won't you. That was quite a basic set of parameters to work with, wasn't it? I know that if that had been more freeform and open-ended, that would have been rather worse. So, they had a Whitburn trail which was highly

structured, and they had the opportunity to deviate and go as far as they want away from it, within the parameters of making it workable and interesting. I don't know about you but the thing I was coming across again and again was the lack of challenge, the lack of depth, and the kind of things they were asking was really just playing with the technology rather than [engaging with the history]"

- [teacher] "[student]'s looked coherent in terms of the actual structure. But when he was asked about what he was asking them to do, he had no thought."

- [teacher] "It's worth cogitating about what parameters you probably need to introduce, to guide them towards deeper thinking. I think it's more of a success for the technology, the medium, than the actual content. It needs to be worth doing, there's no point in having all of the bells and whistles if there's no substance."

- [researcher] "Some of them said they found it a bit easier than others did to convert to the pen and paper, because they were less reliant on the app's features. I don't know how true that was."
- [teacher] "I think it depends on how they were thinking about the task in the first place - maybe, if they'd been highly creative, obviously they'd struggle, but if they were highly creative and lost their focus, then they'd be miles away. If they were less creative, but focused on the nature of the content they'd probably find it easier to transpose. What we want is something in-between."

Observation: Showchild's repeated engagement about how to improve his QR code task – wanted to create a richer activity. Implies that the creation session was too short, lacked enough explanation.

Teaching Pressures & Limitations

Time pressure

- [teacher] “It’s just time pressure, isn’t it? I’m trying to meet so many times, it just... numbs you, so busy.”

Data privacy issues with new tech platforms + data formats

- [teacher] "What about [sharing] kids’ voices – are voices ok? They don’t mention who they are, do they? So it should be. [...] I should know, but I don’t. It’s not something we ever come across, you see."

Sharing Activities & Knowledge with Others

- [headteacher] "You really need to listen to what they [Year 4] have to say, because they have designed this themselves. They are your teacher, ok? And I would like Year 4s to tell me if there’s anyone not listening to you, ok? Please listen, because they’ve worked really hard–they’ve worked two weeks doing this, and they’re really excited about you having a go."

Self organising groups - younger kids wanted to make sure they got to do all of the activities, were keeping track of which Year 4s they had been with

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- [teacher] “Which part of it did you enjoy most?”
- [student3] “Today, getting to go around and swap with other people and getting to find out about theirs”
- [teacher] “So then did that help you, when you had a go at someone else’s, did it make you think ‘oh, we could have done this on our app’, or?
- [student3] “Yeah”
- [researcher] “Do you think swapping was quite important? Do you think that made it more interesting?”
- [students] “Yes”

- [researcher] “Do you think it helped that it was people in your class that you were swapping with? Or if it was another school or something, do you think that would be interesting, if you made stuff for another school, and you used theirs?”
- [student7] “I think that if we made stuff for another school that made them learn it would be really good, because you could make it about your school.”
- [teacher] “Yeah that would be really interesting. We’ve talked about Mia’s school, she’s out in the countryside where there’s like, ten children in a class. That’s a very different school experience to what you have here, so that would be an interesting thing to do, wouldn’t it? To swap it and see what their daily life is like and what yours is like.”

Teachers recognising the value of children exchanging activities and ideas

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- [teacher] “I think that would have been better, wouldn’t it? If we’d actually done it and then taken a different group of children out to use it, but it’s just time pressure, isn’t it. So I think that if they had then in the final stages gone out with perhaps a partner from another class-so that might have worked. So if you did it with one class, and when they finish, take the other class with them, and they’ve got to show it and not take over. And then they can evaluate: ‘Oh, I should have done this, perhaps if I’d done that it would have been better’-watching the other child do it.”

- [teacher] “I run a school for the children [at the fair], so if you want to come and do a project with Showmens’ children, if you want to do a cultural minority, they are cultural minority. [...] Their lives are so different, that actually it would be a nice tool to share with other children what it’s like to be a Showman. It’s a totally different way of life. [...] And the children would love to do something, because as I say their work packs are super dull.”

Children sharing technical knowledge with newcomers

- [teacher1] “I’ll know what those 8 [potential topics] will be. It’ll come under the umbrella of the kids get to take ownership of it, because they get to choose what they want to research. But we’ll steer it, so that they do research those things.”

- [child3] “How do we do the app?”
- [researcher] “Oh! Have you not done it before?”
- [child1] “No cos she goes swimming. I’ll help Phoebe”
- [researcher] “Are you able to work together on it?”
- [child1] “Yeah!”

Children identifying the value of sharing their knowledge

- [researcher] “How are we doing? ‘How deep is the well?’ That’s a good one.”
- [child3] “This is actually helpful, because some people didn’t get to see the well.”
- [researcher] “Yeah that’s a good idea. So are you making a quiz to teach them about it?”
- [child3] “Yep”

Activity Creation as a PBL End-Product

Ownership and sharing of activities enhancing PBL

- [teacher1] “Looking at how to properly analyse photographs, give them frames of reference, things like that. But, in terms of an end goal - I thought this (points at app) would be a nice thing to do.”
- [teacher2] “Yeah, that’s how we’d want to do it. Sounds good”
- [teacher1] “No it really does. Because we do these lessons just as lessons, but the fact that they now mean something in terms of an end product. It’s not just like, here’s some maps- find out what’s changed. We’re gonna make this app and we’re going to do a hunt, find out what’s changed and find something that you’re going to research. Just makes it that much more meaningful”

[teacher1] “Making that app will be mint. If you can make it so that they all submit their own activities...that would be fab. I think this will be an amazing project.”

Approach supports a variety of learner preferences & interests

- [researcher] "And what was your favourite thing about doing it?"
- [child1] "I enjoyed being the teacher."
- [child2] "Being outside"
- [child3] "I enjoyed making the app itself"

Note: School had been warned about its lack of 'social mobility', lacking drama and other courses. Teacher noted that engaging with both local communities and researchers had a positive impact

References

Ahn, J., Clegg, T., Yip, J., Bonsignore, E., Pauw, D., Cabrera, L., Hernly, K., Pitt, C., Mills, K., Salazar, A., et al. (2018). Science everywhere: Designing public, tangible displays to connect youth learning across settings. In *Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems*, page 278. ACM.

Al-Balushi, S. M. and Al-Aamri, S. S. (2014). The effect of environmental science projects on students environmental knowledge and science attitudes. *International Research in Geographical and Environmental Education*.

Bailey, B., Richardson, D., Wright, P., and Crivellaro, C. (2020). Places in Transition: The Effect of Technology on the Changing Role of Urban Centres. *Manuscript in preparation*.

Balaam, M., Comber, R., Jenkins, E., Sutton, S., and Garbett, A. (2015). Feedfinder: a location-mapping mobile application for breastfeeding women. In *Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems*, pages 1709–1718.

Balestrini, M., Bird, J., Marshall, P., Zaro, A., and Rogers, Y. (2014). Understanding Sustained Community Engagement: A Case Study in Heritage Preservation in Rural Argentina. In *Proceedings of the 32nd annual ACM conference on Human factors in computing systems - CHI '14*.

Barab, S. and Squire, K. (2004). Design-based research: Putting a stake in the ground. *Journal of the Learning Sciences*, 13(1):1–14.

BBC Sunday Politics (2013). Localism Act & Neighbourhood Plans May Not Work - BBC (National Planning Policy Framework) - YouTube. https://www.youtube.com/watch?v=fP7hu41smYw. Accessed 2019-04-26.

Bell, S. (2010). Project-Based Learning for the 21st Century: Skills for the Future. *The Clearing House: A Journal of Educational Strategies, Issues and Ideas*.

Bell, T., Alexander, J., Freeman, I., and Grimley, M. (2009). Computer Science Unplugged: School Students Doing Real Computing Without Computers. *The NZ Journal of Applied Computing and Information Technology*, 13(1):20–29.

Ben Rogers (2010). Cameron's speech strongest on Big Society | Financial Times. https://www.ft.com/content/4dc03ba8-d151-11df-8422-00144feabdc0. Accessed 2019-04-26.

Blumenfeld, P. C., Soloway, E., Marx, R. W., Krajcik, J. S., Guzdial, M., and Palincsar, A. (1991). Motivating Project-Based Learning: Sustaining the Doing, Supporting the Learning. *Educational Psychologist*.

Blythe, M., Reid, J., Wright, P., and Geelhoed, E. (2006). Interdisciplinary criticism: Analysing the experience of riot! a location-sensitive digital narrative. *Behaviour and Information Technology*.

Boaler, J. (1999). Mathematics for the moment, or the millennium? *Education Week*.

British Educational Suppliers Association (2015). Tablet adoption continues to rise; barriers to adoption shift - BESA. https://www.besa.org.uk/news/besa-press-release-tablet-adoption-continues-rise-barriers-adoption-shift/. Accessed 2019-07-26.

British Educational Suppliers Association (2017). key UK education statistics - BESA. https://www.besa.org.uk/key-uk-education-statistics/. Accessed 2019-07-26.

Brown, A. L. (1992). Design experiments: Theoretical and methodological challenges in creating complex interventions in classroom settings. *The journal of the learning sciences*, 2(2):141–178.

Burton, D. and May, S. (2015). Citizenship Education in Secondary Schools in England. *Educational Futures*, 7(1).

Cahill, C., Kuhn, A., Schmoll, S., Pompe, A., and Quintana, C. (2010). Zydeco: Using mobile and web technologies to support seamless inquiry between museum and school contexts. In *Proceedings of the 9th International Conference on Interaction Design and Children*, pages 174–177. ACM.

Chan, L. K., Bridges, S. M., Doherty, I., Ng, M. L., Jin, J., Sharma, N., Chan, N. K., and Lai, H. Y. Y. (2015). A qualitative study on how health professional students and their pbl facilitators perceive the use of mobile devices during pbl. *Interdisciplinary Journal of Problem-Based Learning*, 9(1):12.

Chan, T.-W., Roschelle, J., Hsi, S., Kinshuk, K., Sharples, M., Brown, T., Patton, C., Cherniavsky, J., Pea, R. D., Norris, C., Soloway, E., Balacheff, N., Scardamalia, M., Dillenbourg, P., Looi, C.-K., Milrad, M., and Hoppe, U. (2006). One-to-one technology-enhanced learning: an opportunity for global research collaboration. *Research and Practice in Technology Enhanced Learning*, 1(1):3–29.

ChanLin, L. J. (2008). Technology integration applied to project-based learning in science. *Innovations in Education and Teaching International*.

Chatting, D., Wilkinson, G., Marshall, K., Desjardins, A., Green, D., Kirk, D., and Boucher, A. (2017). Making home: Asserting agency in the age of iot. In *Proceedings of the 2017 CHI Conference Extended Abstracts on Human Factors in Computing Systems*, CHI EA '17, page 526–533, New York, NY, USA. Association for Computing Machinery.

Clark, A. (2018). 'Nothing to worry about. The water is fine': how Flint poisoned its people | News | The Guardian. https://www.theguardian.com/news/2018/jul/03/nothing-to-worry-about-the-water-is-fine-how-flint-michigan-poisoned-its-people. Accessed 2019-01-23.

Cobb, P., Confrey, J., DiSessa, A., Lehrer, R., and Schauble, L. (2003). Design experiments in educational research. *Educational researcher*, 32(1):9–13.

Collins, A. (1992). Toward a design science of education. In *New directions in educational technology*, pages 15–22. Springer.

Costabile, M. F., De Angeli, A., Lanzilotti, R., Ardito, C., Buono, P., and Pederson, T. (2008). Explore! Possibilities and Challenges of Mobile Learning. In *CHI 2008, April 5–10,*, pages 145–154.

Cresswell, T. (2016). Foreword. In Freestone, R. and Liu, E., editors, *Place and placelessness revisited*. Routledge.

Crivellaro, C., Anderson, R., Lambton-Howard, D., Nappey, T., Olivier, P., Vlachokyriakos, V., Wilson, A., and Wright, P. (2019). Infrastructuring public service transformation: Creating collaborative spaces between communities and institutions through hci research. *ACM Trans. Comput.-Hum. Interact.*, 26(3).

Crivellaro, C., Taylor, A., Vlachokyriakos, V., Comber, R., Nissen, B., and Wright, P. (2016). Re-Making Places: HCI , 'Community Building' and Change. *CHI'16, May 07-12, 2016, San Jose, CA, USA*.

Crompton, H. (2013). A historical overview of mobile learning: Toward learner-centered education. In *Handbook of Mobile Learning*, pages 3–14. Routledge.

Daily Post (2017). Brexit means we can reopen mines and cotton mills - scargill. https://www.walesonline.co.uk/news/politics/brexit-means-can-reopen-mines-12809927.

Dewey, J. (1938). Experience and Education. *Education*, 50(3):96.

Dodds, C., Kharrufa, A., Preston, A., Preston, C., and Olivier, P. (2017). Remix portal: Connecting classrooms with local music communities. In *Proceedings of the 8th International Conference on Communities and Technologies*, C&T '17, page 203–212, New York, NY, USA. Association for Computing Machinery.

Dourish, P. (2006). Implications for design. *SIGCHI Conference on Human Factors in Computing Systems (CHI'06)*, pages 541–550.

Dourish, P. and Bell, G. (2007). The infrastructure of experience and the experience of infrastructure: Meaning and structure in everyday encounters with space. *Environment and Planning B: Planning and Design*, 34(3):414–430.

Dow, A., Vines, J., Comber, R., and Wilson, R. (2016). ThoughtCloud: Exploring the Role of Feedback Technologies in Care Organisations. *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems - CHI '16*.

Education, D. f. (2011). Framework for the national curriculum. https://www.gov.uk/government/publications/framework-for-the-national-curriculum-a-report-by-the-expert-panel-for-the-national-curriculum-revi

Engeström, Y. (2001). Expansive learning at work: Toward an activity theoretical reconceptualization. *Journal of Education and Work*, 14(1):133–156.

Engeström, Y. (2015). *Learning by expanding*. Cambridge University Press.

Ferragina, E. and Arrigoni, A. (2017). The rise and fall of social capital: requiem for a theory? *Political Studies Review*, 15(3):355–367.

Fiennes, C., Oliver, E., Dickson, K., Escobar, D., Romans, A., and Oliver, S. (2015). The existing evidence-base about the effectiveness of outdoor learning. *Institute of Outdoor Learning: London, UK*.

Fischer, G. (2004). Social creativity: Turning barriers into opportunities for collaborative design. *PDC 2004 - Proceedings of the Eight Participatory Design Conference 2004 - Artful Integration: Interweaving Media, Materials and Practices*, pages 152–161.

Fox, S. and Le Dantec, C. (2014). Community Historians: Scaffolding Community Engagement Through Culture and Heritage. *Designing Interactive Systems (DIS)*.

Frohberg, D., Göth, C., and Schwabe, G. (2009). Mobile Learning Projects - a critical analysis of the state of the art. *Journal of Computer Assisted Learning*, 25:307–331.

Garbett, A., Comber, R., Jenkins, E., and Olivier, P. (2016). App Movement. In *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems - CHI '16*, pages 26–37, New York, New York, USA. ACM Press.

Gerstmann, J. (2016). VRodeo: 06: Google Earth in VR, Serious Sam, and More - Giant Bomb. https://www.giantbomb.com/shows/vrodeo-06-google-earth-in-vr-serious-sam-and-more/2970-12283. Accessed 2019-04-03.

Giaccardi, E., Leysia, P., and Taylor, F. (2008). The Social Production of Heritage through Cross-media Interaction: Making Place for Place-making. *International Journal of Heritage Studies*, 14(10):281–297.

Giemza, A., Malzahn, N., and Hoppe, U. H. (2013). Mobilogue: Creating and conducting mobile learning scenarios in informal settings. In *Proceedings of the 21st International Conference on Computers in Education, ICCE 2013*, pages 489–498.

Google (2016). Google Earth VR. https://vr.google.com/earth/. Accessed 2019-04-03.

Google (2020). Bringing virtual and augmented reality to school | google for education. https://edu.google.com/products/vr-ar. Accessed 2020-01-03.

Gryl, I. and Jekel, T. (2012). Re-centring Geoinformation in Secondary Education: Toward a Spatial Citizenship Approach. *Cartographica: The International Journal for Geographic Information and Geovisualization*, 47(1):18–28.

Gryl, I. and Jekel, T. (2018). Spatially informed citizenship education as an approach for global understanding. In *Geography Education for Global Understanding*, pages 43–56. Springer.

Harrison, S. and Dourish, P. (1996). Re-place-ing space: the roles of place and space in collaborative systems. In *Proceedings of the 1996 ACM conference on Computer supported cooperative work*, pages 67–76.

Harvey, D. (2012). What is Outdoor Learning? https://www.outdoor-learning-research.org/Portals/0/Research%20Documents/Horizons%20Archive/H57.WhatIsOutdoorLearning.pdf.

Hayes, G. R. (2011). The relationship of action research to human-computer interaction. *ACM Transactions on Computer-Human Interaction (TOCHI)*, 18(3):1–20.

Heritage Lottery Fund (2014). State of UK Public Parks. https://www.hlf.org.uk/state-uk-public-parks. Accessed 2016-07-26.

Herrington, A., Herrington, J., and Mantei, J. (2009). Design principles for mobile learning. In *New technologies, new pedagogies: Mobile learning in higher education*. Faculty of Education, University of Wollongong.

Heslop, P., Preston, A., Reid, A., and Kharrufa, A. (2017). Students' Perceptions of Learning Processes as Co-Authors of Digital Tabletop Activities. In *British HCI*.

Historic England (2020). Listed Buildings. https://historicengland.org.uk/listing/what-is-designation/listed-buildings/. Accessed 2020-06-03.

Holubova, R. (2008). Effective Teaching Methods–Project-based Learning in Physics. *US-China Education Review*, pages 27–35.

Ibrahim, S. and Alkire, S. (2007). Agency and empowerment: A proposal for internationally comparable indicators. *Oxford development studies*, 35(4):379–403.

Innovation Unit (2016). Why the UK needs to understand when and how PBL really 'works' | Innovation Unit | New solutions for thriving societies. https://www.innovationunit.org/thoughts/why-the-uk-needs-to-do-more-to-understand-when-and-how-project-based-learning-really-works/. Accessed 2019-07-26.

Javornik, A., Kostopoulou, E., Rogers, Y., Fatah gen Schieck, A., Koutsolampros, P., Maria Moutinho, A., and Julier, S. (2019). An experimental study on the role of augmented reality content type in an outdoor site exploration. *Behaviour & Information Technology*, 38(1):9–27.

Johnson, I., MacDonald, A., Briggs, J., and Manuel, J. (2017). Community Conversational: Supporting and Capturing Political Deliberation in Local Consultation Processes. *Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems*.

Khan Academy (2011). Khan Academy. http://www.khanacademy.org/.

Kharrufa, A., Leat, D., and Olivier, P. (2010). Digital Mysteries : Designing for Learning at the Tabletop. In *ITS'10, November 7-10, 2010, Saarbrucken, Germany*, pages 197–206.

Kharrufa, A. S. (2010). *Digital tabletops and collaborative learning*. PhD thesis, Newcastle University.

Kirkham, R., Ebassa, R., Montague, K., Morrissey, K., Vlachokyriakos, V., Weise, S., and Olivier, P. (2017). WheelieMap: an exploratory system for qualitative reports of inaccessibility in the built environment. In *Proceedings of the 19th International Conference on Human-Computer Interaction with Mobile Devices and Services - MobileHCI '17*.

Krajcik, J. S. and Blumenfeld, P. C. (2006). *Project-Based Learning Handbook*. Cambridge University Press.

Kudryavtsev, A., Stedman, R. C., and Krasny, M. E. (2012). Sense of place in environmental education. *Environmental Education Research*.

Kuh, G. D. (1996). Guiding Principles for Creating Seamless Learning Environments for Undergraduates. *Journal of College Student Development*, 37:135–148.

Kuhn, A., Cahill, C., Quintana, C., and Schmoll, S. (2011). Using tags to encourage reflection and annotation on data during nomadic inquiry. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, pages 667–670. ACM.

Lambton-Howard, D., Anderson, R., Montague, K., Garbett, A., Hazeldine, S., Alvarez, C., Sweeney, J. A., Olivier, P., Kharrufa, A., and Nappey, T. (2019). Whatfutures: Designing large-scale engagements on whatsapp. In *Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems*, CHI '19, New York, NY, USA. Association for Computing Machinery.

Land, S. M., Zimmerman, H. T., Choi, G. W., Seely, B. J., and Mahoney, M. R. (2015). Design of Mobile Learning for Outdoor Environments. *Educational Media and Technology Yearbook*, 39(39):101–113.

Larmer, J. and Mergendoller, J. R. (2019). Gold standard pbl: Essential project design elements. https://my.pblworks.org/resource/document/gold_standard_pbl_essential_project_design_elements.

Lave, J. (1991). Situating learning in communities of practice. In Resnick, L. B., Levine, J. M., and Teasley, S. D., editors, *Perspectives on socially shared cognition*, pages 63–82. American Psychological Association.

Lave, J., Wenger, E., et al. (1991). *Situated learning: Legitimate peripheral participation*. Cambridge university press.

Leat, D. (2015). 'Turning Schools Inside Out': Developing Curriculum with Community Partners | BERA. https://www.bera.ac.uk/blog/turning-schools-inside-out-developing-curriculum-with-community-partners. Accessed 2016-08-22.

Lentini, L. and Decortis, F. (2010). Space and places: When interacting with and in physical space becomes a meaningful experience. *Personal and Ubiquitous Computing*, 14(5):407–415.

Leont'ev, A. N. (1978). Activity, consciousness, and personality. *Moscow: Progress*.

Löchtefeld, M. (2019). Detournavigator - using google location history to generate unfamiliar personal routes. In *Extended Abstracts of the 2019 CHI Conference on Human Factors in Computing Systems*, CHI EA '19, pages LBW1117:1–LBW1117:6, New York, NY, USA. ACM.

Lonsdale, P., Baber, C., Sharples, M., Byrne, W., Arvanitis, T. N., Brundell, P., and Beale, R. (2004). Context awareness for MOBIlearn: creating an engaging learning experience in an art museum. *Proceedings of MLEARN*, pages 115–118.

Lotc.org (2006). LOtC Manifesto | Council for Learning Outside the Classroom. http://www.lotc.org.uk/about/manifesto/. Accessed 2016-07-26.

MacDonald, C. (2012). Understanding participatory action research: A qualitative research methodology option. *The Canadian Journal of Action Research*, 13(2):34–50.

Malpas, J. (1999). *Place and experience: A philosophical topography*. Cambridge University Press.

Mann, A.-M., Hinrichs, U., Read, J. C., and Quigley, A. (2016). Facilitator, Functionary, Friend or Foe?: Studying the Role of iPads within Learning Activities Across a School Year. In *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems - CHI '16*, pages 1833–1845.

Marder, J. (2016). Pokemon go nuisance litigation, 3:16-cv-04300. https://www.courtlistener.com/docket/4183016/in-re-pokemon-go-nuisance-litigation/.

Massey, A. P., Ramesh, V., and Khatri, V. (2006). Design, development and assessment of mobile applications: The case for problem-based learning. *IEEE Transactions on Education*.

McCarthy, J. and Wright, P. (2005). Technology in place: Dialogics of technology, place and self. In *Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)*.

Meissner, J. L., Vines, J., McLaughlin, J., Nappey, T., Maksimova, J., and Wright, P. (2017). Do-it-yourself empowerment as experienced by novice makers with disabilities. In *Proceedings of the 2017 Conference on Designing Interactive Systems*, DIS '17, page 1053–1065, New York, NY, USA. Association for Computing Machinery.

Michigan Civil Rights Commission (2017). The Flint Water Crisis: Systemic Racism Through the Lens of Flint. https://www.michigan.gov/documents/mdcr/VFlintCrisisRep-F-Edited3-13-17_554317_7.pdf.

Ministry of Housing Communities & Local Government (2011). Localism Act 2011: overview - GOV.UK. https://www.gov.uk/government/publications/localism-act-2011-overview. Accessed 2019-04-23.

National Council for Voluntary Organisations (2019). What are the demographics of volunteers? https://data.ncvo.org.uk/volunteering/demographics/.

Newcastle Literary and Philosophical Society (2007). Remembering slavery: Archive and mapping project. http://www.antislavery.ac.uk/items/show/393.

Noss, R. and Hoyles, C. (2017). Constructionism and microworlds. In Duval, E., Sharples, M., and Sutherland, R., editors, *Technology Enhanced Learning: Research Themes*, pages 29–35. Springer.

Nowell, L. S., Norris, J. M., White, D. E., and Moules, N. J. (2017). Thematic analysis: Striving to meet the trustworthiness criteria. *International journal of qualitative methods*, 16(1):1609406917733847.

Ofsted (2008). Learning outside the classroom: how far should you go? http://dera.ioe.ac.uk/9253/1/Learningoutsidetheclassroom.pdf.

Ofsted (2013). Citizenship consolidated? http://www.ofsted.gov.uk/resources/citizenship-consolidated-survey-of-citizenship-schools-between-2009-and-2012. Accessed 2017-02-03.

Ofsted and Spielman, A. (2018). HMCI commentary: curriculum and the new education inspection framework - GOV.UK. https://www.gov.uk/government/speeches/hmci-commentary-curriculum-and-the-new-education-inspection-framework. Accessed 2019-07-25.

Olivier, P. and Wright, P. (2015). Digital civics: taking a local turn. *interactions*, 22(4):61–63.

Papert, S. and Harel, I. (1991). Situating constructionism. *Constructionism*, 36(2):1–11.

Peacock, S., Anderson, R., and Crivellaro, C. (2018). Streets for people: Engaging children in placemaking through a socio-technical process. In *Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems*, CHI '18, New York, NY, USA. Association for Computing Machinery.

Prost, S., Vlachokyriakos, V., Midgley, J., Heron, G., Meziant, K., and Crivellaro, C. (2019). Infrastructuring food democracy: The formation of a local food hub in the context of socio-economic deprivation. *Proc. ACM Hum.-Comput. Interact.*, 3(CSCW).

Puussaar, A., Johnson, I. G., Montague, K., James, P., and Wright, P. (2018). Making open data work for civic advocacy. *Proc. ACM Hum.-Comput. Interact.*, 2(CSCW):143:1–143:20.

Rahman, F. (2018). Integrating project-based learning in mobile development course to enhance student learning experience. In *Proceedings of the 19th Annual SIG Conference on Information Technology Education*, SIGITE '18, pages 1–6, New York, NY, USA. ACM.

Rainey, J., Alvarez, C., Richardson, D., Lambton-Howard, D., Bartindale, T., Hazeldine, S., Briggs, P., Olivier, P., and Montague, K. (2020). TalkFutures: Supporting Qualitative Practices in Distributed Community Engagements. In *Proceedings of the 2020 on Designing Interactive Systems Conference*, DIS '20, New York, NY, USA. Association for Computing Machinery.

Rainey, J., Montague, K., Briggs, P., Anderson, R., Nappey, T., and Olivier, P. (2019). Gabber: Supporting voice in participatory qualitative practices. In *Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems*, CHI '19, pages 377:1–377:12, New York, NY, USA. ACM.

Reeves, T. C. (2000). Enhancing the worth of instructional technology research through "design experiments" and other development research strategies. *International perspectives on instructional technology research for the 21st century*, 27:1–15.

Relph, E. (1976). Place and Placelessness. In Seamon, D. and Sowers, J., editors, *Research in planning and design*, pages 43–52. Sage London.

Relph, E. (2018). A Summary Version of Place and Placelessness. https://www.academia.edu/36528536/A_Summary_Version_of_Place_and_Placelessness.

Richards, L. and Morse, J. M. (2013). *Readme first for a user's guide to qualitative methods*. Sage.

Richardson, D., Crivellaro, C., Kharrufa, A., Montague, K., and Olivier, P. (2017). Exploring Public Places as Infrastructures for Civic M-Learning. In *Proceedings of the 8th International Conference on Communities and Technologies - C&T '17*, pages 222–231. ACM Press.

Richardson, D., Jarusriboonchai, P., Montague, K., and Kharrufa, A. (2018). Parklearn: creating, sharing and engaging with place-based activities for seamless mobile learning. In *Proceedings of the 20th International Conference on Human-Computer Interaction with Mobile Devices and Services - MobileHCI '18*.

Richardson, D. and Kharrufa, A. (2020). We are the greatest showmen: Configuring a framework for project-based mobile learning. In *Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems*, CHI '20, New York, NY, USA. Association for Computing Machinery.

Rogers, Y., Connelly, K., Hazlewood, W., and Tedesco, L. (2010). Enhancing learning: a study of how mobile devices can facilitate sensemaking. *Personal and Ubiquitous Computing*, 14(2):111–124.

Rogers, Y., Stanton, D., Thompson, M., Weal, M., Price, S., Fitzpatrick, G., Fleck, R., Harris, E., Smith, H., Randell, C., Muller, H., and O'Malley, C. (2004). Ambient wood. *Proceeding of the 2004 conference on Interaction design and children building a community - IDC '04*, pages 3–10.

Rowlands, J. (1997). *Questioning empowerment: Working with women in Honduras*. Oxfam.

Sarangapani, V., Kharrufa, A., Balaam, M., Leat, D., and Wright, P. (2016). Virtual.cultural.collaboration: Mobile phones, video technology, and cross-cultural learning. In *Proceedings of the 18th International Conference on Human-Computer Interaction with Mobile Devices and Services*, MobileHCI '16, pages 341–352, New York, NY, USA. ACM.

Sarangapani, V., Kharuffa, A., Leat, D., and Wright, P. (2018). Creating interactive digital content: A cross-cultural approach to develop critical peer feedback. In *Proceedings of the 32nd International BCS Human Computer Interaction Conference*, HCI '18, pages 31:1–31:11. BCS Learning & Development Ltd.

Sharples, M. (2013). Mobile learning: research, practice and challenges. *Distance Education in China*, 3(5):5–11.

Sharples, M., Aristeidou, M., Villasclaras-Fernández, E., Herodotou, C., and Scanlon, E. (2017). The Sense-it App. *International Journal of Mobile and Blended Learning*.

Sharples, M., Taylor, J., and Vavoula, G. (2007). A Theory of Learning for the Mobile Age. *Learning*, 85(3):221–247.

Shih, J.-l., Chuang, C.-W., and Hwang, G.-J. (2010). An inquiry-based mobile learning approach to enhancing social science learning effectiveness. *Educational Technology & Society*, 13(4):50–62.

Sing (2017). Talking Statues - About. http://talkingstatues.co.uk/about.php. Accessed 2017-01-26.

Smith, C. J. (1978). Book review: Place and placelessness. In *Geographical Review*, volume 68. Taylor & Francis, Ltd.

Stanton, D., Bayon, V., Neale, H., Ghali, A., Benford, S., Cobb, S., Ingram, R., O'Malley, C., Wilson, J., and Pridmore, T. (2001). Classroom collaboration in the design of tangible interfaces for storytelling. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, CHI '01, pages 482–489. ACM.

Star, S. L. (1999). The Ethnography of Infrastructure. *Journal of Composite Materials*, 33(10):928–940.

Statistica (2018). Children smartphone ownership 2018 | Statista. https://www.statista.com/statistics/912577/children-smartphone-ownership-uk/. Accessed 2019-07-26.

Stringer, E. T. (2013). *Action research*. Sage publications.

Taylor, J., Sharples, M., O'Malley, C., Vavoula, G., and Waycott, J. (2006). Towards a task model for mobile learning: a dialectical approach. *International Journal of Learning Technology*.

The Education Endowment Foundation (2018). Project-Based Learning | Projects | EEF. https://educationendowmentfoundation.org.uk/projects-and-evaluation/projects/project-based-learning. Accessed 2019-07-26.

The Independent (2004). A coal miners' tragedy: the village split by a 20-year feud. https://www.independent.co.uk/news/uk/this-britain/a-coal-miners-tragedy-the-village-split-by-a-20-year-feud-7907517.html.

Traxler, J. (2013). Mobile learning: Shaping the frontiers of learning technologies in global context. In *Reshaping learning*, pages 237–251. Springer.

Traxler, J. and Wishart, J., editors (2011). *Making mobile learning work: Case studies of practice*. ESCalate.

Tuan, Y.-F. (1978). *Space and place: The perspective of experience*. U of Minnesota Press.

UN Environment World Conservation Monitoring Centre (2014). UK National Ecosystem Assessment: Synthesis of the Key Findings. https://www.unep-wcmc.org/resources-and-data/the-uk-national-ecosystem-assessment--synthesis-of-the-key-findings-and-technical-reports. Accessed 2016-07-26.

Valderrama Bahamondez, E. d. C., Winkler, C., and Schmidt, A. (2011). Utilizing multimedia capabilities of mobile phones to support teaching in schools in rural panama. In *Proceedings of the 2011 annual conference on Human factors in computing systems - CHI '11*, page 935, New York, New York, USA. ACM Press.

Vavoula, G., Sharples, M., Rudman, P., Meek, J., and Lonsdale, P. (2009). Myartspace: Design and evaluation of support for learning with multimedia phones between classrooms and museums. *Computers and Education*, 53(2):286–299.

Venn-Wycherley, M. and Kharrufa, A. (2019). Hope for computing education: Towards the infrastructuring of support for university-school partnerships. In *Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems*, CHI '19, New York, NY, USA. Association for Computing Machinery.

Vlachokyriakos, V., Comber, R., Ladha, K., Taylor, N., Dunphy, P., McCorry, P., and Olivier, P. (2014). PosterVote: expanding the action repertoire for local political activism. In *Proceedings of the 2014 Conference on Designing Interactive Systems (DIS '14)*, pages 795–804.

Walzer, M. (2008). *Spheres of justice: A defense of pluralism and equality*. Basic books.

Wegerif, R. (2007). *Dialogic education and technology: Expanding the space of learning*, volume 7. Springer Science & Business Media.

Wheeler-Hall, S. (2017). Accessibility and Stairs Do Not Mix Well | accessibilitymatters.ca. http://accessibilitymatters.ca/accessibility-and-stairs-do-not-mix-well/. Accessed 2019-01-23.

Whiteley, P. (2012). Does Citizenship Education Work? Evidence from a Decade of Citizenship Education in Secondary Schools in England. *Parliamentary Affairs*, 67(3):513–535.

Wikipedia (2020). List of countries by smartphone penetration. https://en.wikipedia.org/wiki/List_of_countries_by_smartphone_penetration.

WildKnowledge (2015). WildKnowledge. http://www.wildknowledge.co.uk. Accessed 2017-08-15.

Wong, L.-H. and Looi, C.-K. (2011). What seams do we remove in mobile-assisted seamless learning? A critical review of the literature. *Computers & Education*, 57(4):2364–2381.

Wood, G., Anderson, L., Clarke, A., Wright, P. C., Vines, J., Balaam, M., Taylor, N., Smith, T., Crivellaro, C., Mensah, J., Limon, H., and Challis, J. (2014). The Department of Hidden Stories: Playful Digital Storytelling for Children in a Public Library. In *Proceedings of the 32nd annual ACM conference on Human factors in computing systems - CHI '14*, pages 1885–1894.

Wurdinger, S., Haar, J., Hugg, R., and Bezon, J. (2007). A qualitative study using project-based learning in a mainstream middle school. *Improving Schools*.

Xamarin (2016). Mobile App Development & App Creation Software - Xamarin. https://www.xamarin.com/. Accessed 2016-08-26.

Zimmerman, J., Forlizzi, J., and Evenson, S. (2007). Research through design as a method for interaction design research in hci. In *Proceedings of the SIGCHI conference on Human factors in computing systems*, pages 493–502.