Learning and Researching Across Places in Mobile City Science

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Contents

Abstract

This chapter explores a relationship between *learning* across places and *researching* across places. Location-aware devices play an important role in research on teaching and learning as more learning settings incorporate mobile technologies. However, collecting and managing the data produced by these

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technologies takes coordination, particularly when learning is happening at the scale of the neighborhood and when research sites are geographically distributed. This chapter examines the use of mobile and geolocative technologies in research on teaching and learning through a description of a novel approach called Mobile City Science (MCS). MCS is a project that brings together university-based researchers and youth-serving organizations (i.e., a science museum, after-school programs, and schools) in three US cities to support young people in developing locative literacies (Taylor 2017) through their study of local issues. By collecting, analyzing, and developing arguments with spatial data and mobile technologies, MCS participants learned what is involved in contributing to change processes at the city or neighborhood scale. These same data served to inform researchers about learning processes related to new spatial literacies, even when researchers and collaborators were located in geographically separate places. This chapter identifies a set of key design practices for studying and implementing MCS and then applies these to commonplace notions of smart and connected cities.

Introduction: Mobile City Science and Smart and Connected Communities

This chapter explores a relationship between *learning* throughout a place and *researching* across places. Location-aware devices play a key role in research on teaching and learning as more learning settings incorporate mobile technologies (see "▶ VR and AR for Future Education"). However, collecting and managing the data produced by these technologies takes coordination, particularly when learning is happening at the scale of the neighborhood and when research sites are geographically distributed across different states. This chapter examines the use of mobile and geolocative technologies to research teaching and learning by describing Mobile City Science (MCS). MCS is a project that brought together university-based researchers and youth-serving organizations (i.e., a science museum, after-school programs, and schools) in three US cities to support young people in developing locative literacies (Taylor 2017) through their study of local issues.

Participants used location-enabled mobile technologies like Garmin GPS devices, GPS-enabled action cameras, mobile phones, and mapping technologies to locate and re-present places of personal interest through their neighborhoods (see "▶ Augmented Reality in Education"). Implementing MCS in multiple cities required designing a suite of mobile learning activities while also encouraging local redesigns and novel uses of mobile technology that made sense within different neighborhoods. Collaborating participants and a team of researchers developed emergent practices and flexible tactics to effectively work with spatial data throughout the data collection, data sharing, and data analysis phases of the project. Such tactics resulted in key design practices that extend current ideas about "smart and connected" cities and communities. These design practices are foundational for studies of mobile learning that seek to engage participants in addressing neighborhood-scale issues. This is significant as the implementation of novel mobile teaching and learning projects increasingly involves geographically distributed research partnerships (Gallagher and Freeman 2011; Hannerz 2003) and geolocative data sources (Hall et al. 2016; Taylor 2017).

This chapter describes how MCS has made promising contributions to a more robust and critical understanding of smart and connected cities. Specifically, MCS implementations have demonstrated how to support youth in imagining smarter cities through their own data collection and scientific inquiry practices. Through data collection, youth have been encouraged to notice their community assets and challenges, such as a lack of civic infrastructure (e.g., bicycle lanes, recreation centers). In this respect, youth are encouraged to propose data-driven solutions for smarter and more connected cities that are not merely technical but also require strengthening relationships among diverse citizens, stakeholders, and organizations. Insights from the MCS project suggest smarter cities are also more humane cities and that youth's data-informed inquiry processes can be directed toward civically engaged sociotechnical development.

MCS is guided by the idea that young people have valuable knowledge about places that can inform and enrich change processes at the scale of the city or neighborhood. On the one hand, a research project like MCS is predicated on the desire to create "smart and connected" communities by supporting new forms of youth civic engagement. On the other, MCS implementation across three cities expanded what it might mean to be "smart" or "connected" in today's urban environments. This chapter explores these issues by examining the relationship between instantiations of mobile and location-based data during local, on-site implementation (of participating youth and facilitators within two city neighborhoods) and long distance, and online collaborations (between facilitators and researchers across three different cities) in the MCS project.

Location-Aware and Mobile Technology in Research on Teaching and Learning

Designing for – and in response to – mobility is increasingly a focus of research that attends to learning across settings, timescales, and cultural contexts (see "► Characteristics of Mobile Teaching and Learning"). Mobile learning approaches like MCS reorient curriculum activities around traditionally undervalued and underutilized learning resources. Research projects like MCS bring attention to the critical importance of the moving body and mobility in all learning (Hall et al. 2016; Streeck et al. 2011; Taylor and Hall 2013). MCS builds upon promising theoretical and curriculum advances in learning "on-the-move" (Taylor and Hall 2013; Taylor 2017) by using location-aware and wearable technologies to create place-based and mobile experiences for K-12 and postsecondary learners (e.g., Hall et al. 2016; Holden 2016; Kalir 2016; Rosner et al. 2015; Taylor and Hall 2013; Taylor 2017; Taylor and Silvis 2017).

Mobile, location-based technologies not only augment the experience of learning *in* places, but they also focus attention *on* the place and social context in which learning occurs. Moreover, some scholars have argued that places are not transparently seen on maps or in locations; they are actively constructed by experiences in situ (Taylor and Phillips 2017). Methods of participatory mapping (i.e., Gordon et al. 2016; Taylor and Hall 2013) have been developed to address just this question of how experiences in and mobility through places contribute to "placemaking" (Taylor and Phillips 2017). These methods increasingly rely on interactive maps and GIS technologies, which enable narratives about places to be shared and edited across locations.

Smart and Connected Cities Initiatives

The research reported in this chapter was initially conceived and organized during a National Science Foundation-funded workshop titled *Smart and Connected Communities for Learning: A Cyberlearning Innovation Lab*. Both MCS and this workshop reflect a broader interest in the development of smart and connected cities and attendant issues for learning (Gianna and Divitini 2015). "City science" is an interdisciplinary field that sits at the nexus of urban planning and data science and aims to develop strategies and infrastructures for more efficient, equitable, and "smarter" cities. Smart and connected paradigms position state-of-the-art technology as the solution to global problems associated with urbanization (Angelidou 2015). Connecting more people, more goods, and more services to the grid is seen as a solution to historically unequal resource distribution, access, and opportunity. Ubiquitous mobile computing and large, rich data sets are essential components of smart and connected paradigms, which promise to improve all manner of urban systems from transit to environmental protection (Townsend 2013). While some are optimistic that having more people connected to urban infrastructures and collecting their own data (e.g., on air quality or mobility) will result in a collective ability to produce new ideas and engage in data-driven decision-making (Angelidou 2015), others are more circumspect about the nature of this data; user-generated data presents new questions about whose property the data will be, to what purposes it will be directed, and who stands to benefit from collecting and mobilizing city-scale data (Picon 2015).

Questions about the participatory design of smart and connected cities are not new to the field of community planning and urban development (Gordon et al. 2016). Mapping sits at the intersection of this debate because location-based technologies are embedded in increasingly ubiquitous mobile devices, such as smartphones. Open Mapping Software such as Google Earth (Farman 2010) and Google Maps (Elwood and Leszczynsky 2013) and AR technology (Wilson 2011) make it more possible than ever for users to create cartographic content and make changes to map layers that can influence city planning and design of urban infrastructure. Moreover, today digital maps are accessed by people outside of traditional domains of city planning or civil engineering; maps are increasingly used to give spatially indexed accounts of everyday experiences and to address practical, "on the ground" needs (Taylor 2017). For youth and professionals, who are interested in addressing community-based issues and contributing to designs for smarter and more connected cities (Kingston 2007; Taylor and Hall 2013), location-based technologies and digital mapping applications present new avenues for advocacy.

MCS Curriculum Design and Description of Activities

Mobile City Science is a project, funded by the National Science Foundation (#1645102), that studied how two groups of urban youth collected, analyzed, and developed arguments with spatial data using mobile and location-aware technologies. One goal of the project was to support educators to better understand the places in which students live. Another intended outcome was for students to develop technical knowledge and capacities for civic engagement that can extend beyond the curriculum. In some cases, the data students gathered while participating in the project contributed to ongoing processes of change and urban planning in their neighborhoods. For example, in a midsouth city, where the MCS curriculum originated, participating youth brought the attention of city planners to the lack of youth-oriented transit options in their neighborhood, and eventually a bike lane was installed in this "mobility desert" (Taylor and Hall 2013). While advocating for material changes to city infrastructures focusing on transit and mobility is not a requisite element of MCS, all participants have opportunities to gather data and form spatial arguments about their neighborhood through a series of learning activities.

MCS Curriculum Activities for Collecting Data

Because MCS emphasized moving around the city in order to understand the assets and opportunities in the local environs, learners' early activities involved immersive fieldwork and data collection. Through a series of semi-structured, field-based inquiries using wearable cameras and geolocative devices – as well as paper maps and paper-based tools like trace paper and pencils – students gathered information about their neighborhood that could then be analyzed and organized into arguments for change.

Before setting out, facilitators guided students through *free recall mapping*, an activity that introduces maps as a representational form (Hart 1977). Facilitators asked participants to produce a map of their neighborhood or community, a relatively open-ended prompt that allowed students interpretive and representational leeway. Participants went on to describe what they drew and the reasons for including these attributes (e.g., sidewalks, houses, gardens) on their maps.

Next, in the *walking audit*, students used a paper map to navigate to several nearby locations of interest such as libraries, parks, faith-based sites, and other locally significant cultural institutions. The focus of this activity was on what might be missing on the map, or conversely, what might be depicted on the map

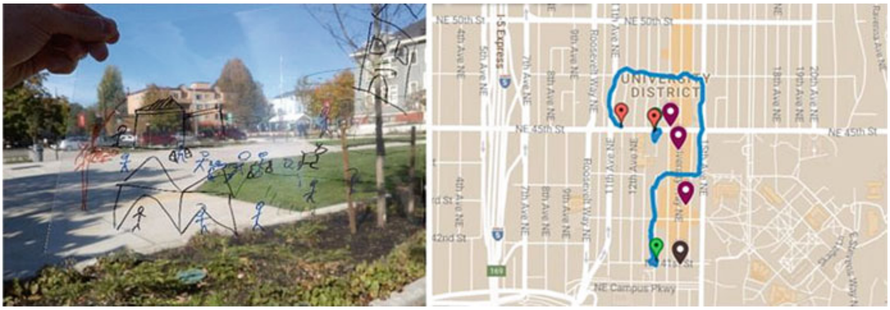


Fig. 1 (**a**) Participants reconstruct the local Farmers' Market on transparency film during the Historic Geocache activity in Seattle. (**b**) A question mark "walked" by participants in the GPS Drawing activity symbolizes change and uncertainty in the city

that was inconsistent with reality. While on site at these places, students discussed how they use or might use the space, and they also recalled previous experiences (if any) they may have had there.

The *historic geocache* activity introduced participants to the use of digital maps for navigating to places, as they found their way to a number of preset waypoints that had been determined (typically, by facilitators) to have historical significance. While on site, participants produced some representation of the place using a variety of tools and media, such as mobile phones, paper and pens, transparency film, etc. (Fig. 1a). Depending on the location and local design of this activity, participants also interviewed experts at the site; local stakeholders' institutional knowledge served as relevant data for students' future analysis.

A final data collection activity, *GPS drawing*, was an opportunity for students to then use the GPS devices to produce a personally meaningful symbol over a map of some nearby area (Lauriault and Wood 2009). Students first planned the shape they would draw on paper maps, making decisions about scale and route. They then set off through the neighborhood once again, using the device to create a set of GPS tracks that, when layered onto Google Maps, took the shape of their planned symbol (Fig. 1b). Walking the neighborhood in this way not only gave youth a new perspective on the map – as a representation collaboratively created by map-makers and users (Gordon et al. 2016; Taylor and Hall 2013) – it also introduced them to spatial ideas related to scale and the geometry of the built environment. GPS drawing allowed them to use the spatial arrangement of the environment and their own mobility as resources for learning (Taylor 2017).

Activities for Analyzing Data

As students returned from each field-based activity, and with the help of facilitators, they transferred their video and GPS files from cameras and Garmin devices to online file storage systems, making this data available for their own analysis. Each session between field trips was an opportunity to discuss observations from prior activities, troubleshoot technical difficulties, and debrief firsthand experiences in the neighborhood. These conversations functioned as early informal analyses that shaped how students conceived of local issues as they proceeded in the curriculum.

Once they had some video and photographic data – from images collected during the walking audit, for example – students began creating an annotated map of their observations and ideas. This was facilitated through debriefing the field observations with an eye to what was missing, inconsistent, or problematic in terms of use or mobility but also with a focus on what was available to neighborhood residents and how (and if) people accessed such assets. This *asset map* – once populated with locally derived, on-the-move and on-site, youth-produced data – would inform their determination of what (if any) changes they might recommend in terms of local innovations or infrastructural improvements.

Activities for Making Spatial Arguments

Finally, facilitators supported youth to organize their analyses of mapped data into categories of issues that could be used to develop plans for change. Based on the kinds of observations students made, there may have been a particularly "live" problem that emerged from data analysis. Alternatively, individual students or groups might converge on a number of key issues salient to them. These then served as the grounds for producing *counter-maps* (e.g., Peluso 1995) of the neighborhood, which represented proposed changes and highlighted what students saw as missing places, assets, or features. The process of counter-mapping involved further analyzing or iterating on the asset map, toward the creation of a new map or spatially-referenced artifact that represented a youth perspective on proposed changes to the environment (Taylor 2013; Taylor and Hall 2013).

These proposals were then made public in various ways. One approach was to organize a community meeting with stakeholders and decision-makers, and involved invited experts, such as urban planners, transit officials, or local public servants and elected officials. The purpose of this onetime meeting was to create the conditions for an active *design charrette* in which youth lead participating attendees through a process of redesign based on their findings from field work and their data analysis. Another approach was for a partner school to organize a final showcase event, which invited participation from professionals and other community members. This event could occur at school and may combine elements of both hands-on design work and a cumulative presentation. This type of event presented an opportunity for other students and educators from the partner school to learn about MCS activities and outcomes. Finally, it is also possible to present MCS programming at a standing community-based meeting, such as those organized by civic- or faith-based groups. This approach has the advantage of amplifying youth voice in settings that may (for various reasons) typically lack young people's perspectives and brings youth into conversation with diverse stakeholder audiences.

MCS Research Collaborations and Training

The project described in this chapter was a pilot study that emerged from a place-based, mobile teaching and learning social design experiment in a midsouth city. MCS was originally implemented in partnership with a youth-serving organization; the design team was led by this chapter's third author (Taylor 2013, 2017; Taylor and Hall 2013). As an extension of this earlier research, the pilot study described in this chapter was organized as a collaboration among the University of Washington and researchers and organization leadership from the Digital Youth Network (DYN) and the New York Hall of Science (NYSCI). Under the auspices of designing and building capacity for smart and connected cities, this collaborative and cross-setting project was launched to pursue three interrelated goals. First, MCS partners sought to implement curriculum activities that positioned youth, their interests, and their data-driven argumentation as levers for smarter and more connected urban communities. Second, project partners would iterate MCS across multiple urban contexts to establish a smarter and more connected research community committed to the investigation of youth learning on-the-move with location-aware and mobile technologies. Third, the pilot was organized to establish connections across out-of-school and in-school settings that would articulate how MCS could support place-based, mobile, and digitally mediated learning and thereby could be adapted by educators and organizations in other cities.

Partnerships in this MCS pilot also engaged local secondary schools in both Chicago and New York City (The names of partner secondary schools – and their students and staff – in both Chicago, and Corona, Queens, are pseudonyms.). DYN's MCS programming in a neighborhood on the southside of Chicago occurred through a partnership with Evergreen Academy, a public secondary school of approximately 200 students defined by a distinctive arts- and technology-infused curriculum. DYN facilitated MCS as an extension of the organization's well-documented and highly successful digital media and learning programming (Barron et al. 2014). In a neighborhood in the borough of Queens, NYSCI partnered with Global Science Academy (GSA), a public secondary school of approximately 300 students affiliated with a larger network of international-themed schools primarily (though not exclusively) located in New York City. The partnership between NYSCI and GSA was rooted in the work of Queens 20/20, NYSCI's initiative to engage young people and families from the neighborhood surrounding the museum in out-of-school STEM learning opportunities.

For the purposes of describing university research collaborations with partner organizations in this chapter, staff and researchers at the partner organizations (i.e., DYN and NYSCI) and the university-based research coordinators are collectively referred to as the "research team." Youth who participated in MCS at the secondary schools are referred to here as "participants," although they were also considered "researchers." For clarity, the three present authors are referred to in this chapter as "researchers." In order, the authors were the Research Associate (RA), Program Evaluator (PE), and Principal Investigator (PI). The role of the RA was to coordinate the sharing of data, to manage the data repository, and to perform initial analysis of data as it was collected. The role of the PE was to visit sites during implementation, to observe and document ongoing implementation activities, and to review and assess culminating events and final program outcomes. The role of the PI was to train all facilitators and the research team to implement MCS activities, to oversee all research activities, and to generally keep the mobile learning and teaching environment moving. The roles of the staff and researchers at the partner organizations are described in more detail in section "MCS Curriculum Implementations."

Prior to implementation at the partner sites, researchers hosted a training week for visiting members of the research team at their campus in Seattle. One member of the NYSCI team and two members of the DYN team attended the MCS Seattle training. There were several goals of this meeting. First, researchers intended to introduce team members across research sites to each other. Second, they introduced all team members to the MCS curriculum and presented an overview of how it had been designed and initially implemented. And third, they began planning for local implementations in Chicago and New York City. The primary task achieved during the Seattle training was to practice each of the MCS activities in some form, so that future facilitators had firsthand experience collecting, analyzing, and arguing from mobile and spatial data. Of course, this was somewhat abbreviated in the interest of time and team building. Nonetheless, and surprising even to us, salient local issues – such as gentrification and economic development – emerged as rich sources of analysis and conversation while practicing curriculum activities over the span of just days. Facilitators' and researchers' initial experiences of learning to "teach" MCS as mobile "learners" themselves were invaluable once local implementations in Chicago and New York were underway.

Learning to collect and then analyze spatial data was an essential element of the Seattle training. In addition, the team established conventions for collaboratively managing data that would enable us to share and systematically analyze it across sites. Before summarizing what took place during local implementations of this mobile teaching and learning curriculum in Chicago and New York City, it is worth mentioning how the Seattle training set the stage for the more technical- and data-oriented aspects of the project which would become critical focal points for both researchers and youth participants.

Data collection was primarily, though not exclusively, a responsibility of DYN and NYSCI as implementation and research partners; therefore, researchers worked to ensure they were comfortable using what, to some of us, were new technologies (e.g., GPS devices, point of view cameras), file formats (e.g., .mov, .gpx), and research methods (e.g., video recording, mobile mapping). Field notes from the Seattle training indicate how critical this part of the work was to the success of the partnership:

> When we were not out on the move getting to know each other and the city, we were inside downloading and discussing the data we had collected during MCS mapping activities. However, to get to the stage of downloading the data, literally hours of technical work had to be performed... Unpacking all the devices, setting them up to record data, learning how to

operate new technologies, and making sure they were charged were ongoing activities on the way to making the data available to process and debrief (excerpt from fieldnotes).

In the interest of transparency and to inform future implementations of MCS, it is worth noting that placing primary responsibility for data collection on DYN and NYSCI was a big ask. Once implementation commenced, the sociotechnical work of arranging for technologically mediated mobile learning was a heavy lift and required ongoing attention and troubleshooting. Nonetheless, the local benefits of the mobile learning curriculum outweighed these local challenges. The following section further describes the design and implementation of MCS at the two pilot sites and illustrates what was involved in learning and researching across places. This is followed by an elaboration of key practices that emerged from implementations.

MCS Curriculum Implementations

In this pilot study, the first MCS implementation took place in a south Chicago neighborhood in the fall of 2016. As most of the mobile, mapping activities in MCS happen outdoors, the climate of a particular location presents a wider or narrower window for implementation. With approximately 10 weeks of planned curriculum activities at Evergreen Academy, when DYN began facilitating MCS, they were rapidly approaching the cold weather season in a location known for harsh winters. In consultation with Evergreen's principal, MCS was implemented in the first period of a Grade 9 science class and ran from October through December, 3 days per week, for all students enrolled in the class. In January through March of 2017, a subset of these students continued to coordinate a plan for the culminating design charrette.

In Chicago, DYN's facilitation team included three core researchers at their organization, Caitlin, Tene, and Elaina, and a team of three part-time facilitators, Jim, Dimress, and Asia, whose assistance depended on the nature of the MCS activity on any given day. For example, during field-based mobile mapping activities, four different facilitators each accompanied a group of three to four students who carried GoPro cameras, Garmin GPS devices, and paper maps around the neighborhood while they collected data. During these mobile activities, facilitators also served as data collectors, carrying or wearing cameras or later documenting field notes. Another role of the facilitators in this MCS program was to plan and organize curriculum activities before each class session, including transporting and distributing mobile tools and technologies, creating any necessary paper-based maps and instructions for students, and generally managing the roles and responsibilities of students in small groups. Much of this team's planning for each class session also involved contacting local businesses, researching local points of interest, and coordinating the students' visits to these sites beforehand (Fig. 2).

At the end of DYN's 5-month MCS implementation, students at Evergreen Academy defined and developed arguments to address a number of issues about their neighborhood. Students' place-based inquiry identified a central problem: *There was a lack of youth-oriented after-school opportunities in the neighborhood*

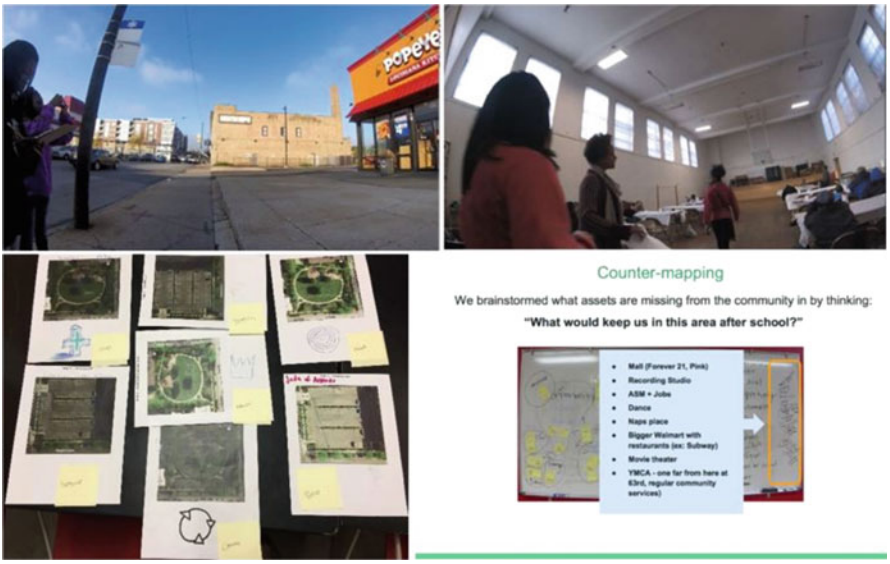


Fig. 2 (Clockwise from top left) Students on the Walking Audit photograph Popeye's Chicken restaurant, which they report "brings lots of business to the neighborhood." During the historic geocache, a group of students visits a local church's free breakfast and meet with a clergyman who has coordinated this service since 1979. A slide excerpted from their final presentation depicting how they categorized assets and converged around a common hyperlocal problem. A collection of students' plans for shapes they will "draw" by walking in park and a parking lot near Evergreen Academy

around their school. They tied this central problem to a lack of youth employment options, a lack of space for artistic production (i.e., studio space), and a lack of recreation centers. In some instances, participating youth also connected their lack of employment, artistic, and recreational opportunities to the troubling effects of Chicago's well-documented struggles with gun violence (Gunderson 2017). The data they had collected while traveling around their neighborhood during MCS activities, talking to longtime business owners and religious leaders, and then creating asset maps of the area had given them a picture of the neighborhood as changing and gentrifying. They imagined what kinds of conditions and amenities might keep them in the neighborhood after school. Their design plan disclosed – from a youth perspective – how this could also serve as a place of potential renewal for people whose connections to places may have been severed by generations of social inequality, violence, and racism.

About the same time, MCS activities wrapped up in Chicago, the pilot's second iteration commenced in the New York City borough of Queens. NYSCI's MCS implementation at GSA was unique in a variety of ways. First, participating students – like all students at GSA – had lived in the United States for no more than 4 years prior to their enrollment at the school; in other words, they were all recent immigrants. Second, the 12 students who participated in MCS did so voluntarily as an after-school elective associated with their school-wide health sciences curriculum. Third, the majority of students were in Grade 12, though several were in Grade 11, in contrast to the younger cohort in Chicago. NYSCI's implementation of MCS at GSA began in late March, 2017, and culminated in early June. Participants met for MCS activities twice a week, on Tuesday afternoons for an hour following school, and for five Saturday sessions that lasted for approximately 3 h each. One Tuesday after-school session had to be canceled because of a snow storm that shut down New York City public schools for the day.

There were three core NYSCI facilitators, Catherine and Anthony, who were present at most MCS sessions and, Andres, who was also co-Principal Investigator of the larger research project. In addition, GSA students' social studies teacher, Ms. Julia, who was supervising the juniors and seniors taking this course as an elective, participated in some of the classroom-based activities. GSA's principal accompanied the students on most of the field-based mobile activities outside of school. Facilitators ran the intensive field-based sessions on Saturdays, which gave more time (and more extensive mileage) to mobile data collection activities. However, holding sessions on the weekends sometimes resulted in low attendance, and not all participants were present for all activities because of their work and family commitments. In contrast to prior MCS curriculum iterations, NYSCI facilitators asked GSA students to select many of the neighborhood sites they visited, creating new sorts of challenges and opportunities for mobile mapping and learning about places (Fig. 3).

The students at GSA developed their own sets of issues and arguments that emerged from what they learned while traveling around their neighborhood and locating themselves in its history. Rather than converging on a single theme, such as "transit/mobility" (as in the original MCS implementation), "change" (during the Seattle facilitator training), or "after-school opportunities" (DYN's implementation in Chicago), the students at GSA identified a number of unique, personally relevant themes and built their spatial arguments around these topics. Some students worked individually, while others collaborated in pairs to construct evidence-based claims and then present these to local stakeholders at their culminating event. Given that GSA was planning graduation ceremonies for their first class of Grade 12 students at NYSCI in late June, it was easy to coordinate the museum hosting the final MCS event.

During the final community presentation, one particularly vocal student, who was present at all MCS meetings and Saturday sessions, keyed into what he called a lack of "friendliness" and openness to meeting and talking with new people in his area of Queens, a neighborhood known for its ethnic diversity. His solution was to develop a nearby park into a "Friendship Park" designed for communion and conviviality in this dense and lively urban center. Other participant projects concerned youth-focused designs around mobility and recreation or common urban challenges such as local tourism and waste management. Given the strong diversity of international backgrounds and histories among GSA participants, it is not surprising that their inquiries led them to perceive such a wide range of challenges and opportunities in their neighborhood.

Fig. 3 (Clockwise from top left) During the walking audit, a group of students collects transit data by tallying bus arrival times on a hand- drawn map and using Garmin GPS to navigate between stops. Students investigate the history of Corona as part of their planning of a historic walk that they organize with facilitators. One student shows her "perspective viewpoint" of the street where she lives and highlights an abandoned building that she and her friends say is a "haunted house." Another student shows facilitators and peers his planned location for designing Friendship Park as a solution to a relevant hyperlocal issue

Key MCS Design Practices

For MCS participants – *and for the researchers studying their learning* – arriving at a set of arguments and articulating locally relevant issues involved a number of key design practices. During MCS curriculum activities, participants developed new knowledge by traveling around their neighborhoods, collecting geolocative data, and analyzing data through the lens of youth experiences. During all phases of MCS implementation, researchers' methodological activities, organizational partnerships, and facilitation of the curriculum were likewise animated by these same activities. The remainder of this chapter discusses two principal design practices for MCS which were both relevant for *researching* across places and also for youth *learning* throughout places. These design practices represent important considerations for both researchers conducting this type of mobile learning research and for youth participating in mobile learning curricula. These design practices also contribute to new ways of conceptualizing – and building – smart and connected communities.

Getting "Smart" with Data

Establishing norms for data collection and exchange across people and places is part of any research project (Ribes 2014). This necessarily involves coming to a shared understanding (with collaborators or participants) about what the nature of data will be and how data will be used. In many multi-sited research projects, the collection and analysis of data are used primarily *internally* by researchers to understand participants' activities or to engage in iterative design (e.g., Cole 2006). MCS was different in that youth participants used the data they generated to analyze problems and construct scientific claims of their own. The forms of these two instantiations of data (i.e., researchers' and students') were often the same (e.g., video recorded observations of students' field work), though they served different purposes and were understood through different perspectives. Moreover, while some data served both researchers' and students' interests, other data were pertinent only to one constituency (Fig. 4).

For example, one student who analyzed local bus schedules and routes as a problem for youth mobility in Queens determined that bus arrival times and frequencies were relevant for establishing future plans and recommendations. However, this data had no a priori importance for researchers; it was primarily relevant to students. Conversely, researchers were interested in the very perspectives and processes through which students came to use technology in the city and make sense of their location-based data. The sources of researcher-relevant data quickly proliferated as MCS implementation progressed in the two cities. However, youth were less interested in what researchers saw as valuable data, such as the video recordings researchers gathered about students' perspectives on places and mobility during post-field work debriefs in class.

Determining what data would consist of and how data would be used was a central task of both researchers and students. As students identified salient local issues and iterated on their design solutions, *new forms of data emerged for them, and their notion of what counted as data evolved*. Similarly, researchers planning for MCS implementation anticipated what kinds of data would be relevant to their own analyses, without necessarily knowing in advance what kinds of issues and places would become relevant to youth or how implementation would unfold. In both cases, what was required was developing new approaches to using data or *getting smart with data* (a note on the use of "smart" in 5.1.2). Two examples from the project serve to elaborate this key MCS design practice.

Data-Sharing Sustains Research Collaborations

In order to lay the groundwork for what Loshin (2004) called the "semantic consistency" of data, the research team established a number of information management conventions. During initial research conversations at the Seattle training, researchers discussed file naming and storing conventions, a deceptively mundane part of the research process that obscures its larger implications for collaborative work in distributed knowledge projects (Turner et al. 2006). Figure 5 illustrates the activities involved in managing and sharing data in MCS. While each technique is interrelated with others in making mobile and geolocative data available for analysis

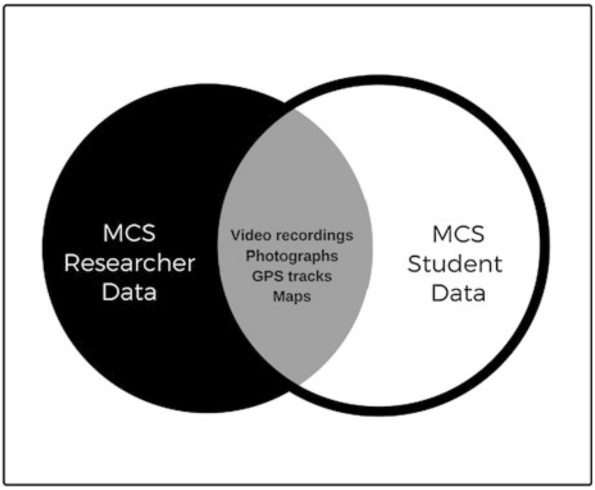


Fig. 4 The overlap between researcher and student data

across sites, each also stands as a discreet example of how research methods were designed around emerging future uses of data. Establishing naming conventions is just one instance in the larger design practice of researchers' "smart" uses of location-based data in MCS.

As illustrated in Fig. 6, through a series of conversations begun at the Seattle training, the research team established file naming convention for all file types (i.e., video, photo, audio, GPS, etc.). Researchers' planning for file naming conventions influenced MCS data management in several ways. First, by suggesting that the file name should include information about each file type (i.e., videos, photos, GPS track data), the research team set up an expectation that any and all of these forms of data would be collected (and could be relevant) in a given curriculum activity. Second, by including information about the individual who collected the data (i.e., student, researcher, person's initials), the research team established each activity as a collective sociotechnical accomplishment. The broader process of getting smart with data – whether in terms of research methods or participants curriculum inquiry – could be considered a collective and distributed sociotechnical accomplishment (Turner et al. 2006). Third, through file naming conventions, the research team communicated the importance of methodological systematicity and shared data conventions for studying learning across places. This relieved facilitators of reinventing the wheel at each new implementation in order to share data across research sites.

Notwithstanding the advantages of establishing such standardized data management procedures, file naming conventions were actively redefined during implementation depending on the local design of activities at partner sites. For example, in Chicago, the division of participants into small groups necessitated an additional field in the file name that differentiated by group. In New York City, where entire MCS activities were reinvented (e.g., the historic geocache evolved into a larger exploration of the history of Queens), the abbreviated reference simply to "HG" in the filename was insufficient to represent the contents of associated data to researchers across sites.

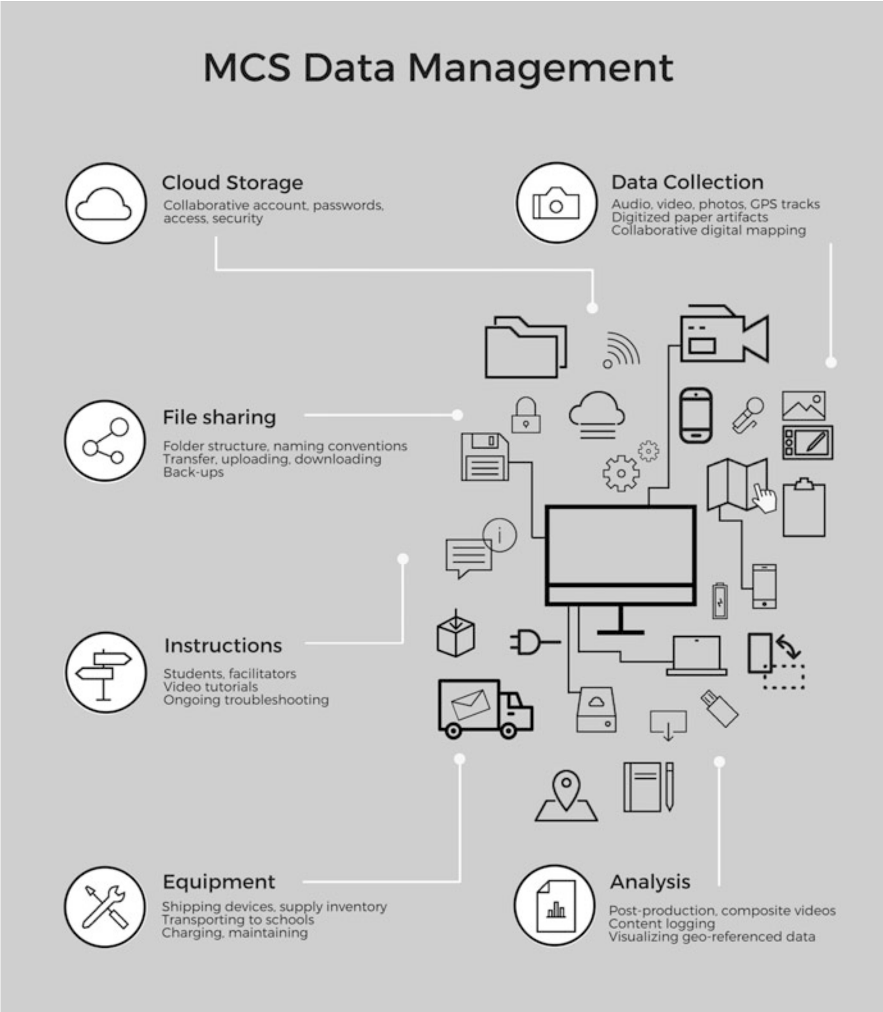
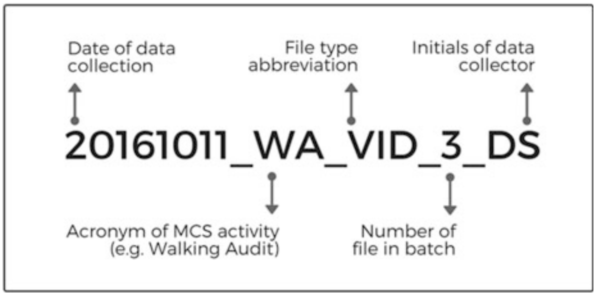


Fig. 5 The interrelated activities for MCS data management

Fig. 6 The elements of MCS file structure



In these cases, getting smart with data involved accommodating the ongoing exigencies of implementation and data collection and incorporating these in terms recognizable to remote collaborators. According to Loshin (2004), "a good naming convention, when it accompanies a well-designed set of abstract data type definitions... will provide a means for easily defining new data objects while conveying semantic meaning to existing named objects" (p. 30). Facilitators distributed across locales were able to maintain coordinated data sharing despite local curriculum redesigns in part because they were scaffolded by an effective approach to data nomenclature. File naming conventions (and their iterations across research sites) were an example of using flexible approaches to data management to support multi-sited collaborative research.

Data Propel Mobile Learning

Like the researchers studying youth learning, participants in MCS found that adopting a flexible approach to data supported their efforts. As an example, after mapping and visiting a number of local health clinics in their neighborhood, a pair of students considered what types of data might answer their emerging questions about these local assets. This conversation took place several weeks into the New York City implementation, after students had already engaged in several field-based activities and in-class sessions. Prior to this debrief in class, students had traveled in small groups with a facilitator to three neighborhood locations that were organized around a chosen theme. This particular group had settled on neighborhood health clinics as representative of the theme "physical health." They had noticed a relatively large number of private clinics and medical offices in their neighborhood, including a large hospital, which they did not visit (though another group did).

During their mobile mapping of these health clinics, the students began to wonder why most were closed on Saturdays when presumably many people would be off to work from their Monday through Friday jobs and might have time to make use of clinic services. During their walk, the students discussed how and when clinics were accessed by local residents, how people traveled there, clinic hours of operation, the appearance and signage of the facilities themselves, and the proximity of clinics relative to each other and to other neighborhood assets like markets and libraries. These on-the-move discussions were video recorded, and one student used a Garmin to navigate to different clinic locations. In the next MCS session, they returned to their questions with a focus on what kind of data they might collect to understand how clinics served the neighborhood.

One student, Brittany, offered the idea that they could interview people who lived around the clinics or who frequented these businesses. She suggested that this would give them a different kind of information than they were able to glean from observing the locations. Her idea stood in contrast to the ways she and other students had talked about data prior to engaging in this activity. Their earlier conceptions of data were that they were "numerical," that they consisted of "charts and graphs," or that they were used as "proof" of something. Brittany's new understanding of data was that it could also consist of the personally relevant interview-based responses of local stakeholders, whose opinions were valuable in defining the problem. New and emergent forms of data were offered as acceptable ways of illustrating problems that youth identified during mobile data collection.

These emerging understandings about data point to how participants developed flexible approaches to data; in other words, they were "getting smart with data." It is not so much that students learned how to collect data and so they "got smart." Rather they broadened their understanding of how particular forms of data are effective tools for building an argument and advocating for something potentially transformative with other community stakeholders. Accordingly, the notion of "smart" that informs MCS is neither normative nor necessarily "taught" through traditional curriculum and pedagogy. Rather, it involved surfacing place-based knowledge about local issues that youth already have (or those they refined through fieldwork and analysis) and then reorienting this existing knowledge toward building an action-oriented argument.

For both students and researchers, getting smart about collecting and using data took both careful planning and considerable flexibility. While the research team benefited from determining before implementation what data would consist of and how it would be managed, researchers also allowed for considering alternative forms and emerging uses of data in situ. For youth, the same key design practice involved recognizing the power of data to make an argument about a local problem, learning to collect representative data, and then harnessing this (or other forms of) data to make a compelling case to local stakeholders. These different forms of knowing or "smartness" were interrelated, with data collection, sharing, and analysis cutting across the work of participants, facilitators, and researchers – as well as across places.

Getting "Connected" to Cities and Sites

As a second design practice, MCS required forging connections at several different levels of activity. At an interpersonal level, *connections among collaborators and participants* included forming friendships in class, building relationships between facilitators and students, and even convening virtual research meetings. At a material level, *technological connections* (e.g., charging devices, maintaining a strong Wi-Fi connection) made it possible to implement a primarily wireless, mobile curriculum and to manage data collection efforts. Thirdly, and at a city scale, it was critical to develop *connections to places* in order to create conditions where youth-led inquiry and recommendations for change held meaning for participants (Taylor and Hall 2013). In this discussion, the focus is on this third level of connection to cities and sites, while recognizing that interpersonal and material connections were also implicated in how researchers and learners connected to and across places. As with the design practice of getting smart with data, two examples represent – from researcher and youth perspectives – how connections to cities and sites emerged in MCS.

Connecting Researchers to Remote Field Sites

During the MCS Seattle training, after 2 days of intensively studying the neighborhood around the University of Washington campus, Catherine, a NYSCI research collaborator, commented that she felt more connected to the U District – the neighborhood under study during facilitator training – than to the neighborhood in Queens more than 2000 miles away, where she had worked for years and would eventually implement MCS. In her words,

> In 2 days I got to know this community [in Seattle], not like the back of my hand, but I feel like I sort of get a certain level, way more than a tourist… but I would say I know this community better than the community outside the doors of NYSCI. Better than... where [GSA] is. I see that [MCS] works. You can't help but get connected to the community because you are talking to the store owners, and also interacting with people on the street. You're learning about the history. It's really very powerful.

She (and others) committed to getting out in the neighborhood on foot and learning about Queens, which was indeed the first thing she and her co-facilitator Anthony did when they prepared for implementation back in New York City. Catherine even proposed the idea of *walking or running* from her home, through Queens, to NYSCI in order to experience familiar routes and routines (i.e., commuting) and places in new ways. To do so, Catherine would have had to walk across a bridge between boroughs, a commute that typically involved taking the subway. The idea of "bridging connections" between personal itineraries and place-based teaching and learning presented an important moment in the project. Collectively, the MCS team recognized that moving around on foot through places was a critical means for connecting to the city and locally relevant issues (Rosner et al. 2015).

While Catherine and other facilitators did make strong connections in and to their city neighborhoods, this design practice also served to inform *remote* research collaborators who were equally invested in getting to know the places under study. Off-site members of the research team relied on facilitators' recordings of field work with students, the traces of their travels left in GPS tracks, and the records of local networking that materialized in curriculum documents to get to know the places students studied. This information served to "ground" youth-collected data and observations, which researchers accessed almost entirely remotely through files stored in the cloud, to the "on the ground" relationships youth were building in their local neighborhoods.

MCS was configured as a multi-sited, multi-city research project, requiring what Hannerz (2003) called "translocal connections" (p. 206). Because place-based mobile teaching and learning were so central to MCS, it was vital *to researchers* to have collaborators on the ground who could forge connections to places (Gallagher and Freeman 2011). Therefore, facilitators were in key roles, articulating between connections to research partners and local connections on the ground. The former made it possible for researchers in Seattle and Denver to get connected to Chicago and Queens. The latter created the possibility that local youth would have mobile learning opportunities in their neighborhood that resonated with their own experiences in and of these places.

Connecting Young People to Local Places

The key practice of making connections to the urban environment is evident throughout curriculum implementations, because all of the MCS activities are in some way designed to connect participants to local places. In Chicago, during the historic geocache activity, a group of students visited a local barber. He spoke with them about the history and processes of gentrification in the area and changes to the neighborhood surrounding their school over the decades his shop had been in business. He highlighted the shifting demographics, commercial opportunities, local politics, and physical landscape of the neighborhood's major thoroughfare, where his business is located. Students interviewed him and then shared these video recorded observations with other peer groups back in class. Debriefing the interview afterward with facilitators, the students who visited the barbershop were ambivalent about the nature of "progress" in the neighborhood. They made associations to similar transformations in the adjacent neighborhoods where they lived, citing personal stories of displacement and change.

For this particular group of youth in Chicago, while they desired jobs and productive after-school activities, the larger problem that surfaced in their analysis of opportunity was a general lack of youth-oriented places in the neighborhood. Some students voiced concern about the prevalence of "gang-banging," and one wrote on their hand-drawn free recall map of the community: "don't shoot, I want to grow up." Given this context – one unfortunately common in American cities (Gunderson 2017) – informal learning opportunities like MCS offer a critical, albeit provisional intervention that create conditions to repair relationships to place. An activity like visiting a barbershop and interviewing the owner opens up possibilities for forging much needed connections between youth and local cultural resources and institutions, which is a key component of building new digital literacies and supporting interest-driven learning (Barron et al. 2014; Ito et al. 2013).

Facilitators played a critical role in the MCS design practice of making connections to cities and field sites. For youth as well as for their adult facilitators, becoming connected to the location under investigation played a role in how they viewed – and eventually advocated for – local issues. This was supported by mobile technology in data collection, analysis, and argumentation activities; however, mobile connectivity was only one aspect of getting youth out-of-school and experiencing their city's past and present, to think about the/ir city's future. To make connections to place, youth relied on their own experiences in and of places. Of course this was heavily supported by facilitators, who brokered connections between youth and local stakeholders. Likewise, for researchers, an understanding of the relevance of places and local issues was mediated by facilitators bridging connections for youth to find mobile learning opportunities in their neighborhoods.

Future Directions for the Design of Mobile Learning Curricula and Research

This chapter has described a mobile learning curriculum for youth living in urban settings that incorporates digital mapping and place-based pedagogies toward encouraging a form of youth participation and civic engagement. The partnership between researchers and youth-serving organizations required spatial and temporal coordination, as mobile and location-based data emerged and were spread across cities and over time. Because both researchers and participating youth used and managed data – and often for different, though sometimes shared, purposes – thinking about data demanded flexibility and an openness to emerging methods of collection or analysis. Moreover, because data collection and fieldwork were primarily the responsibility of members of the research team in Chicago and New York City, making connections to places was pivotal for researchers off-site so that they might make sense of curriculum implementations in these places. These connections were no less important for participating youth, for whom the curriculum was designed. Given these interrelated considerations, getting smart with data and getting connected to places were two key design practices for both MCS researchers and participants.

In MCS, participants and researchers practiced ways of knowing and becoming connected to their local neighborhood. MCS was founded on the idea that young people are already smart about their surroundings and conceived as a means of harnessing new tools to support the unique knowledge they have of their neighborhoods and cities. However, youths' ways of knowing were not aimed at or always entirely aligned with urban development agendas and the making of "smart cities" (Picon 2015). Furthermore, the MCS implementations reported in this chapter help to de-center discourse about "innovation" and "high technology" often associated with smart cities and reorient processes of change toward the local (and sometimes still paper-based) scale where MCS operates and innovates. This involved a process of participants learning how their data were useful, such as one student who described "seeing the neighborhood through new eyes," or for developing spatial arguments about proposed infrastructure and community changes. In the process, students used mobility as a resource for learning and became more connected to the places where they live, attend school, and engage in everyday activities.

A promising outcome of the research reported in this chapter is insight about youth's interconnected perspectives on place, data, and data-driven decision-making. This is perhaps not surprising given that the research team anticipated the kinds of mobile and geolocative data youth would generate and planned for sharing these data across sites. What was unknown at the time of the Seattle training but emerged as a key practice for MCS throughout implementations was how the particularities of local issues would fuel flexible tactics for data collection, management, sharing, and analysis. The implication of this for future adaptations of MCS – and perhaps for other models of multi-sited research on mobile teaching and learning – is that in order to understand participants' learning processes or processes of change at the city-scale, researchers need to also anticipate, and accommodate, changes at the level of curriculum design. That is, local MCS adaptations will be both influenced *by* data and will influence data and how data are used.

Finally, these key MCS design practices contribute to more expansive conceptions of what it means to be (in) a "smart and connected" city or community. Connecting more vital services to the grid or networking cities' communications is important, but future efforts and mandates ought to incorporate the perspectives – and data-driven arguments – of young people. The kind of personally relevant data that youth gathered and analyzed suggests a major gap in the ways city planners and officials tend to think about the problems they confront and solve – often without input from young people (Taylor 2013). With participatory action and sustainability among the goals of smart cities initiatives (Townsend 2013), supporting youth to connect with place, helping youth learn how to use mobile technologies, and advancing youth data-driven decision-making are critical components of developing such future capacities. Moreover, there is another lesson to be taken from the connections youth made throughout the reported MCS implementations: orienting urban design around innovations for cities of the *future* must be coupled with discovering and documenting the social contexts and personal *histories* in which these designs will be placed (e.g., Gordon et al. 2016; Taylor and Hall 2013). Connecting to places in this way will make it more likely that "connected places" of the future will respond to locally relevant needs and desires and that innovative ideas are ideally driven by today's youth.

Cross-References

▶ Augmented Reality in Education
▶ Characteristics of Mobile Teaching and Learning
▶ VR and AR for Future Education

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