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Learning Along Lines: Locative Literacies for Reading and Writing the City

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The “everyware” paradigm opens up new possibilities for learning on-the-move with technologies through urban spaces while also raising questions about emerging literacies required of users to understand and use the digital traces these technologies generate. This article develops locative literacies as a way of understanding place-based, digital modes of reading and writing different representational forms at the scale of the city. I explore a new analytic unit, learning along lines, as a tool for supporting the design and analysis of learning contexts where the leading mode of engagement for young learners was physical and digital mobility through the city. Learning along lines emerged from a design study in which youth produced counter-maps of their neighborhood to share with city stakeholders. Using a spatiotemporal framework, I analyze youth learning locative literacies along lines they made of their neighborhood through a designed task, global positioning system (GPS) drawing. First, I focus on young people learning to scale their mobility to a neighborhood grid along lines they made through walking and gesture. Second, I focus on young people learning to negotiate inscriptions along lines they made by walking with maps and GPS devices through their neighborhood. Third, I focus on youth learning to re-member their embodied effort along lines they made discursively during moments of reflection. The analyses are intended to push the field’s understanding of mobility in conceptualizing and designing new forms of learning locative literacies. Learning along lines foregrounds humans not merely as consumers or generators of texts but as being part of that text, literacy agents of a text they populate.

The ubiquity of location-aware applications and devices increasingly permeates the mundane activity of being mobile in everyday life (e.g., Greenfield, 2010).

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Color versions of one or more of the figures in the article can be found online at <http://www.tandfonline.com/hlms>.

Although this “everyware” paradigm opens up new possibilities for learning on the move (Taylor, 2013) with technologies through urban spaces, it also raises questions about emerging literacies required of users to understand *and use* the digital traces (Latour, 2007) these technologies generate (e.g., Karanasios et al., 2013; Liu, Andris, & Ratti, 2010). In this current context, examining how young people engage with mobile and location-aware technologies around their expanding mobility (both physical and virtual) within their communities has never been more important or more possible.

People rely on location-aware tools to navigate to locations (e.g., using global positioning system [GPS] devices), circumvent points of automobile congestion (e.g., with Mapquest.com/traffic), map workouts (e.g., using Mapmyrun.com), report issues on their streets to metro governments (e.g., using Fixyourstreet.ie), or geotag photos to reflect their current locations and activities (e.g., using Geotag Photos). Most recently, they play games, like Pokemon Go™, with mobile, location-aware technology in which dynamic maps on smartphones mediate their action. These examples show that mobile, location-aware tools are no longer used solely for utilitarian purposes, like wayfinding, but are increasingly used to engage with places in a personally meaningful way and to address practical, on-the-ground needs through maps. Contrast this to the not so distant past in which a group of highly trained professionals created and had access to all of the maps used to understand and make decisions about people’s lived environments (Shekhar, Feiner, & Aref, 2015). Now, locative literacies,¹ place-based, digital modes of reading and writing different representational forms at the scale of the city, is as much a novice-based practice as it is a professional one.

In this article, I address issues of equitable physical and digital mobility within the context of a social design experiment for spatial justice (Taylor, 2013; Taylor & Hall, 2013) that engaged underserved young people in mobile mapping activities through their neighborhood. These activities supported young people, on the move (e.g., on foot, on bicycles) with mobile and location-aware technologies, in making and sharing (with urban planners and city stakeholders) maps of their neighborhood *that addressed practical, community-level issues* (Tate, 1995; Taylor, 2013; Taylor & Hall, 2013). Having never participated in mobile mapping practices with these tools before, young people learned locative literacies for reading and writing the city with mobile and location-aware technologies. Locative literacies were mobile, embodied, place based, and participatory; they built on aspects of critical spatial thinking (e.g., Goodchild & Janelle, 2010; National Research Council, 2006;

¹I understand that invoking literacies as a way to describe social norms and modes of engagement takes a normative stance on teaching and learning. However, the work here follows the lead of Ito et al. (2010) and others who use literacy to describe “a set of standards that are under continuous development and negotiation through social activity” (p. 24).

Solem, Huynh, & Boehm, 2015) and computational fluency (e.g., Barron, Martin, Takeuchi, & Fithian, 2009; diSessa, 2000) to engage youth in innovative forms of civic engagement at the scale of *their* community (e.g., Van Wart, Vakil, & Parikh, 2014). Similar to the intended outcomes of work by Gordon, Elwood, and Mitchell (2016), this design experiment “expanded adult-centric notions of civic agency and developed participatory mapping practices that elicited young people’s knowledge on their own terms” (p. 2).

The purpose of this article is to explore a new analytic unit, learning along lines (Lave & Hall, 2014), as a tool for supporting the design and analysis of learning contexts where the leading mode of engagement for learners was physical and technological mobility through the city. Learning along lines is a kind of participation framework (Goffman, 1981) or “fluid structure of mutual engagement and disengagement” (Jordan & Henderson, 1995, p. 67) that organized bodies, technologies, maps, *and places* along lines that youth read, talked about, walked, drew, gestured, and examined.

At this point, I offer a short hypothetical example to demonstrate locative literacies in action and to foreshadow the usefulness of learning along lines as an analytic unit in a different context than the one that is explored in depth in this study.

An ecology teacher is supporting her students to participate in an ongoing community conservation effort focused on protecting animal habitats. The students are tasked with creating a movement model of different animals that live around the school (e.g., squirrels, beavers). Using a mobile, location-based application on their smartphones called Siftr™, the students walk around the neighborhood mapping habitats and possible pathways to food sources. At each location (*way-point*) and along the pathways (*tracks*), the students capture digital images and compose ecology-themed considerations or challenges for local policymakers and conservation advocates. The students then view the collection of these waypoints and tracks in one map layer. The teacher guides her students along a visual inquiry process to look for patterns in animal movements, food sources, and relations with the built environment of the neighborhood they just walked. Based on these movement models they create, the students make recommendations for where and how to focus local conservation efforts.

In the study described here, learning along lines happened through and about the neighborhood with location-aware and mobile technologies in the service of creating and sharing novel maps of urban daily life as a teenager (cf. Van Wart et al., 2014). First, I focus on young people learning along lines they made through walking and gesture to scale their mobility to a map and then to the neighborhood. Second, I focus on young people learning along lines they made by walking with maps and GPS devices to learn a newly mediated form of joint mobility with location-aware tools and representations. Third, I focus on young

people learning along lines they made discursively to understand the narrative power and limitations of location-aware tools and maps. The analyses are intended to push the field's understanding of embodiment and mobility in conceptualizing accounts and designing new joint forms of learning locative literacies. Learning along lines moves researchers toward empirically "reconceiv[ing] the relations between physical mobility, virtual mobility, and educational mobility as social phenomena" (Leander, Phillips, & Taylor, 2010, p. 330).

In the following section, I describe how this work is situated at the intersection of embodied learning and digital literacy with an emphasis on physical and technological mobility throughout the city. I describe other studies, both within and outside the learning sciences, that have used physical and technological mobility as a resource for learning. I then argue that these ideas necessitate a new analytic unit, learning along lines, to inform the design and analysis of learning environments where mobility is the process and content of learning locative literacies for reading and writing the city. The article goes on to address two research questions:

1. What resources were young people able to take up in learning locative literacies along lines that may be different from learning within places?
2. How did youth learning locative literacies along lines support "continuity across contexts" (Lave, 1988, p. 19) so that on-the-move activities informed more traditional—adult-driven, static—learning arrangements?

FRAMEWORK

Learning (and Teaching) on the Move

What is the relationship between mobility and cognition? Cognitive and learning scientists agree that "the original function of any brain is to control motion—only mobile organisms have brains" (Streeck, Goodwin, & Lebaron, 2011, p. 7). Duranti (1997) wrote, "Thinking subjects do not just think, but they also move, build, touch, feel, and, above all, interact with other beings and material objects through both physical and semiotic activity" (p. 282). For some scholars, such as Tim Ingold (2011), mobility *is* making sense of the world: "Movement is itself the inhabitant's way of knowing" (p. 154). Indeed, for this work, mobility was the process and content of teaching and learning locative literacies—place-based, digital modes of reading and writing different representational forms at the scale of the city.

Yet movement is messy, is hard to control, and easily goes off track. The "changing contextual configuration caused by movement" (Haddington &

Keisanen, 2009, p. 1938) makes it difficult to predict how and what learners will take up to make sense of a designed activity. For these reasons, leveraging physical mobility as a learning resource is still undervalued and underutilized in traditional learning arrangements (Leander, Phillips, & Taylor, 2010). However, some researchers have pushed the possibilities of *seeing* and *using* learning on the move. Ma and Munter (2014), for example, examined how newcomers learned to skateboard in two city skateparks. Others have taken up location-aware and wearable technologies (cf. Lee, 2014) to create place-based, mobile experiences to teach science (Ryokai & Agogino, 2013), critical spatial literacies (Taylor & Hall, 2013), geometry (Hall, Ma, & Nemirovsky, 2015), and aspects of “algorithmic living” (Rosner, Saegusa, Friedland, & Chambliss, 2015, p. 1). In these examples, technologies (e.g., skateboards, GPS devices) re-mediated physical mobilities (i.e., walking, biking) for learning a new way of moving through and seeing the environment. In their work on using GPS devices as a novel means of teaching geometry with students, Hall et al. (2015) suggested, “Bodies are ... located in new ways, creating mobile and diverse perspectives on geometric objects, as well as new capacities to feel and touch aspects of mathematics” (p. 3).

The work of artist Jeremy Wood is a still earlier example of using mobility as a means for learning about and showing a novel experience of a place; he continues to work at the intersection of cartography, art, and geometry (Lauriault & Wood, 2009). Wood made visible his own embodied experiences through the landscape by reappropriating GPS, a tool historically used by the U.S. military to precisely locate and track its missile submarines (Sample, 2014). Wood’s GPS drawings represented a coordinating effort of walking (or driving or biking or swimming) and technology to tell a story about a place. These stories, which others have called “mobile locative narratives” (e.g., Farman, 2014, p. 10), taught viewers about a practiced, lived landscape that an aerial satellite map makes invisible. In this way, physical mobility (mediated by location-aware technology) not only allows the maker to see a place differently through first walking it and then viewing the GPS tracks but also can *teach* an audience about a different experience of that place.

Using mobile mapping technologies to educate an audience highlights how mobility, especially walking, remains an act of political and individual agency (Ingold, 2007; Rosner, Saegusa, Friedland, & Chambliss, 2015; Suchman, 1995). Politically speaking, silent marches, migrations, and memory walks (Bonilla, 2011) have been acts of dissatisfaction with the status quo; these walks represent a process of teaching and learning in which diverse publics inform more powerful others of inequitable lived experiences. The more recent addition of technological mobility allows us as people to easily *represent* how we experience different places along the pathways we travel. Individually

speaking, mobile devices allow users to record and show a changing sense of place-and-self in relation to the changing terrain of neighborhoods and communities (de Souza e Silva & Frith, 2014). For example, a young person walking between school and the library may use Foursquare on her smartphone to represent the following: school as a location of excitement and engagement because of her participation in the talent show, the route through her neighborhood as a pathway of anxiety and discomfort because of high traffic and the lack of sidewalks, her arrival at the library as a location of discretionary time to peruse an impressive collection of manga. Sharing these experiences *across* places highlights how locations not only are connected for an individual but also may influence another user of the mobile application to change his or her own physical mobility based on what someone else has shared.

Embodied, Digital Learning

Blurring the disconnect between the physical and the represented is the basis for embodied learning and is arguably a more authentic means for teaching and learning irrespective of content domain (e.g., Alibali & Nathan, 2012; Farnell, 1999; Glenberg, Gutierrez, Levin, Japuntich, & Kaschak, 2004; Goldin-Meadow, 2009). Embodied learning theorizes learning as a process that is distributed across all of the sense-making modes of the body. This multimodality of sense making is fundamental to not just learning *in situ* but how people have organized perceptual symbol systems (Barsalou, 1999) individually and socially. For instance, Lakoff and Johnson (1980) suggested that seemingly abstracted metaphors are grounded in, or harken back to, some fundamental embodied experience that makes them almost universally understood in interactions.

Still, current theories of embodied learning do not account for how learners leverage *bodies-in-place* as an opportunity for making sense of and producing new community-based practices. In a special issue of the *Journal of the Learning Sciences*, researchers provided arguments for the centrality of the body for learning mathematics (Hall & Nemirovsky, 2012). Although that work has most recently promoted embodied cognition as a viable theory of learning, educators and educational researchers still struggle against the tendency to fetishize abstracted, pure knowledge over the ways in which moving, feeling bodies make sense of the world. In addition, and as Stevens (2012) pointed out in his commentary in the “Modalities of Body Engagement in Mathematical Activity and Learning” special issue of the *Journal of the Learning Sciences*, attempting to build a broad understanding of how the body and learning relate via solely classroom-based studies is a major limitation to robust theory building.

A person’s history within a locality, the particularities of the terrain’s geography and its influence on the body, and the dynamic nature of

neighborhood and community settings are all but absent in current accounts of embodied learning. I argue that one reason for this absence is that the fundamental quality of daily life, that of moving through dynamic places, is difficult to analyze. Some scholars have attempted this work. Marin (2013, 2014) has developed the ambulatory sequence as a unit of analysis for understanding how parents and children learn together on forest walks. Shapiro, Hall, and Heiberger (2015) looked at engagement contours through a museum to trace the changing nature of people's participation as they moved through an exhibit.

An aim of this article is to contribute a new analytic lens—learning along lines—for looking at mobility across scales of meaning making, not just that which happens in the moment. As Creswell (2006) wrote,

What connects mobility at the scale of the body to mobility at other scales is *meaning*. Stories about mobility, stories that are frequently ideological, connect blood cells to street patterns, reproduction to space travel. Movement is rarely just movement; it carries with it the burden of meaning and it is this meaning that jumps scales. (pp. 6–7)

Learning along lines, therefore, attempts to understand how thinking about (e.g., with maps and pencils), doing (i.e., on foot with GPS devices), analyzing (i.e., with geographic information system [GIS] software), and explaining one's movement through a familiar place (i.e., the neighborhood) are resources for learning across scales of the lived and the represented.

Literacies for Reading and Writing the City

Digital literacy provides entrée into considering novel, technologically enhanced ways of “taking meaning (reading) and making meaning (writing)” (Gee, 2012, p. 420) at the scale of the city with location-aware tools. In his book *Changing Minds: Computers, Learning, and Literacy*, diSessa (2000) highlighted the ways in which computers and computing practices have opened up a new suite of inscriptional forms, from electronic images to spreadsheets to hypertext. These infrastructural shifts in literacy practices take hold because they capitalize on the strengths of human intelligence and are largely recognized and valued by a community that shares a common set of representational forms. While diSessa used material, cognitive, and social pillars as a framework to describe computational literacy, learning along lines constructs a fourth pillar, embodiment, to encompass the ways in which mobile, place-based technologies have opened up new literacy practices. The analysis shows that learning along lines foregrounds

humans not merely as consumers or generators of texts but as being part of that text, literacy agents of a text they populate.²

Prinsloo and Roswell (2012) described digital literacies as “placed resources” where “meaning is related to social uses and these are shaped by place and context” (p. 273). All literacy practices are a projection of the reader and/or author’s social reality (Bourdieu, 1984). In this way, work on digital literacy has considered “the set of cultural competencies and social skills” (Jenkins, 2006, p. 4) acquired by young people engaged in online communities (e.g., Jenkins, 2006), gaming worlds (e.g., Gee, 2003), and digitally rich classrooms (e.g., Carrington & Robinson, 2009). These different media ecologies (Sefton-Green, 2006) are particular arrangements of tools, multimedia, talk, writing, and other artifacts. But what happens when one takes media ecologies *outside* and puts them on the move through a community? Little work has yet considered the digital literacies bound up in understanding and making place-based inscriptions with location-aware tools at the scale of the city and how young users might use their bodies as a resource for doing this well. Location-based technologies foreground the relationship bodies-in-place have to reading and writing at the scale of the city.

De Certeau’s (1984) framework of everyday urban practices is useful in understanding how authors of mobile locative narratives, like GPS drawings, “read and write the embodied city” (p. xxi) so that people’s negotiations with and their resistances to the built environment become visible in their representations. It is interesting that the advent of mobile mapping tools has collapsed de Certeau’s distinction between the elevated view (i.e., that of the designed/planned) and the ordinary perspective (i.e., that of people going about their everyday lives) on the text of the city; authors of mobile locative narratives leverage the tools and Cartesian perspective of the elevated view to tell a mobile, emplaced story of affect, embodiment, and history (Hansen, 2014).

But in accordance with de Certeau’s assertions, and as I show in the analytic findings of this work, much of the corporeal still gets lost in the seemingly harmonious marriage between the lived and the represented in writing and especially reading mobile locative narratives. Because these narratives depend on bridging physical and digital/represented spaces, understanding the story requires considerable effort on the part of the audience. Ritchie (2014) suggested that

the story space has the possibility of being harder to understand, due to its existing across two different media spaces to be explored, being potentially bigger than other types of narratives, and requiring audiences to constantly discern what does or doesn’t belong within the storyworld. (pp. 57–58)

²My appreciation to Anonymous Reviewer 1 for helping me clarify this contribution.

In other words, the audience of a mobile locative narrative often needs to be familiar with the qualities of the place over which the story georeferences.

The geoweb—digital, spatial data on the Internet—has provided a forum for geospatial narratives that highlight the ways in which people's personal experiences within and throughout a space can contribute to a collective meaning of place (McFarlane, 2010). Human geographer Sebastian Caquard (2011) suggested, "The idea that a story map is defined by its experiential dimension echoes other researchers' acknowledgements of the importance of developing emotionally charged maps and geovisualizations in order to better understand places and mobilize for action" (p. 136). Representing affect through maps and new geovisualization techniques has been shown to engage residents in political processes of community change (Nold, 2009). However, translating one's endemic knowledge and narratives of home and community into mappable attributes to inform the cartographic gaze remains a complicated ontological issue (Agarwal, 2005; Schuurman, 2006) but one that is vital to the human experience. As Enyedy (2005) described, "Sketches, diagrams, symbols, and so on, are a durable trace of our activity and thought and allow us to abstract, highlight, and coordinate salient aspects of the world around us" (p. 427). Mapping, and thus highlighting, aspects of everyday life through the digitally mobile is not only a relatively new mediation of the physical world but a novel way of learning about, participating in, and potentially *changing* processes of community development (cf. Brantlinger, 2003; Leonard, Russell, Hobbs, & Buchanan, 2013). Now that mapping platforms facilitate adding many different layers of personal data onto a base map of locations, the *self* has been brought to digital representations of space.

With the increasing availability of locative technologies, like public participation global information system software and GPS, urban planners and community organizers are increasingly interested in involving the public, including youth, in connecting on-the-ground and on-the-move experiences to inform the official maps they make (Kingston, 2007). Therefore, even though there has always been a need for spatial thinking (e.g., National Research Council, 2006), being able to think spatially in coordination with mobile, location-aware technologies within the context of one's community is a more recent and pressing demand (and possibility) in the realm of education as it relates to making civically engaged and informed citizens.

METHOD: SOCIAL DESIGN EXPERIMENT

Learning along lines emerged from a larger "social design experiment for spatial justice" (Taylor, 2013, p. 14; Taylor & Hall, 2013) in which young people were positioned not just as learners of newly mediated forms of mobility in the context of their neighborhood but as teachers and change agents within their

community we called “Woodbridge” (Taylor & Hall, 2013). In accordance with how Gutiérrez and Vossoughi (2010) outlined the parts of a social design experiment, our design explicitly built on the history of Woodbridge, took seriously the notion of equity in relation to young people’s positionality in processes of community change, and treated our activities as re-mediations (Cole, 1996) of youth’s physical mobility through the community to promote new ways of learning locative literacies. In what follows, I outline my own experience in and understanding of Woodbridge and why these young people were invested in learning and producing new stories of Woodbridge with maps.

Background

It was important for these particular Woodbridge youth to engage in this design study for three reasons. First, this community was known as a mobility desert; Woodbridge was isolated and severed from the rest of the city by two major interstates and another major traffic corridor. Getting around with or without a car was notoriously difficult. Residents of all ages were unable to quickly and efficiently access grocery stores, parks, and any cultural amenities the city had to offer. At the time of this study, alternative modes of transportation, like riding bicycles, were both uncomfortable and dangerous because of a lack of designated bike lanes and routes.

Second, the six youth in this study were participants in a bicycle building and riding workshop located in the basement of a Woodbridge youth-serving organization. Therefore, they were exceptionally motivated to make Woodbridge a more bicycle-accessible area and to show more powerful entities (e.g., planners, adult stakeholders) what it was like to be a young person trying to get around in a place like Woodbridge. Their experiences as pedestrians and cyclists through Woodbridge as participants in the workshop afforded them new insights into how the infrastructure *and* current maps of the community were inscribed for automobile drivers, not walkers or bicyclists.

Third, the community’s adult residents, in cooperation with urban planners, had just completed a comprehensive plan for the infrastructure of Woodbridge that would, among other things, facilitate better mobility. In observations of that process, we saw that residents’ input, though spatially rich, was grounded in their affective and embodied experiences of moving through and being in Woodbridge (Taylor, 2013; Taylor & Hall, 2011). This kind of input was often deemed by planners as incommensurate with updating the community plan because planners’ static maps and mapping tools were insufficient in *showing* this kind of qualitative experience of place. I began to think of this incommensurability not as a barrier to the community planning process but as an opportunity space for design, especially with new mobile, location-aware tools that

could get people closer to representing embodied and biographical responses to the built environment.

Design of the Mobile Mapping Task

I focus on GPS drawing as one designed task in this study to explore learning along lines as a tool to support the design and analysis of learning contexts where the leading mode of engagement was physical and technological mobility. As mentioned previously, GPS drawing has been used by other researchers to teach geometry (Hall et al., 2015), explore “algorithmic living” (Rosner et al., 2015, p. 1), and teach an audience about a practiced landscape (Lauriault & Wood, 2009). In this study, GPS drawing was one designed activity in a series of mobile mapping activities to promote new ways of learning locative literacies. These activities included ground-truthing maps, historic community geocaches, and counter-mapping (described in greater detail in Taylor & Hall, 2013).

GPS drawing involved two groups of three youth walking a planned route with a handheld Garmin™ GPS device through their neighborhood to create an image or word. When powered up and triangulated via satellite communication, GPS devices record and store the users’ locations and pathways through space. These tracks can be uploaded as a map layer in a GIS. Study participants, in collaboration with one another, location-aware technology, and maps, authored a completely new pathway through Woodbridge that elicited spatial problem solving, their histories in the neighborhood, and identifying the limits of their bodies’ capacities for physical mobility.

In this designed activity, the function of the GPS device was repurposed by inserting the device into a new form of joint activity that layered personal meaning over the map. GPS drawing was a differently mediated form of mobility intended to show youth that location-aware technology could be a representational tool to inscribe and exercise creative agency on a familiar place but also to elicit new ways of thinking about a place that was so familiar to them. Another intention of this design was to support youth in putting their embodied experiences, the map, and the GPS device in tension with one another to experience each one of these as different forms of mediation to the built environment and to see how youth coauthored spaces in a novel way.

There were five phases to the activity. The first phase was a tutorial in which I introduced the idea of GPS drawing to the young people and then we discussed it. The second phase of the activity was for planning what GPS drawings of Woodbridge the youth would produce; the six participants broke into two groups of three people (a girl group and a boy group) with a Google Earth™ satellite map and a Google Maps™ traffic map of the neighborhood and markers. The third phase of GPS drawing was the production stage, in which youth walked

their planned word or image through the neighborhood with the device in hand. The fourth phase was a kind of design critique in which the youth shared their GPS drawings with one another and with the adult researchers and volunteers. The fifth and final phase of the activity happened several months later and was a result of my coordinating meetings with urban planners, cartographers, local Woodbridge stakeholders, and the participants' families for youth to share their GPS drawings and other maps they had created in the context of the larger social design experiment.

Participants

Six 12- to 15-year-old teenagers volunteered to participate in this study. They were recruited from the bike workshop program in which they were already enrolled. Beth, Wallace, Fred, William, Leah, and Carissa (listed in order of ascending age) were all African American youth attending public schools in the city. Beth, Leah, and Carissa were residents of the HOPE VI community (a mixed-income housing development) directly across the street from the workshop. Fred was also a resident of Woodbridge and lived just north of the workshop. William and Wallace lived 6 miles east of the workshop and attended school two blocks from Carissa's house (where she also attended). Although all six participants were familiar with the neighborhood, they were not as familiar with the larger metro area in range for the bicycles they would build. Socially speaking, these six young people were acquainted with one another before the study. Fred and Leah attended the same high school (and rode the same school bus), William and Wallace were brothers, and the respective families of Carissa and Leah were so close to William and Wallace's mother that the four young people referred to one another as "cousins." Mobile mapping activities intentionally built on their familiarity with the neighborhood and with one another.

Data Collection

Over these various phases and locations, we (a research team of five people) made video and audio recordings of youth activity. Because a central component of mobile mapping tasks was the content of young people's activity on foot through the neighborhood, one youth in each group also wore a head camera. Therefore, we had redundant video records of on-the-move activity that offered a researcher's perspective and a young person's perspective on the content of learning along lines through Woodbridge. It is important to note for this study about locative literacies that wearable cameras provided a close-up record of the physicality of the tasks (including audio records of escalating heartbeats) and a perspective on the small screens of GPS devices at which participants were

often looking (Umphress & Sherin, 2014). The maps participants created were saved and treated as artifacts for additional analysis. I also conducted and video recorded follow-up interviews on the last day of the study to get participants' impressions of the designed activities and any additional reflections they might have made over the passing of time.

Data Analysis

The primary purpose of analysis was to understand how young people engaged in learning locative literacies along lines. I was interested in what resources young people were able to take up in learning along lines that may have been different from learning within (or about) places. I was also interested in how youth learning along lines supported "continuity across contexts" (Lave, 1988, p. 19): How were on-the-move activities informing more traditional—adult-driven, static—learning arrangements? These static learning arrangements approximated design charrettes we observed urban planners organize in Woodbridge with adult residents (Taylor, 2013; Taylor & Hall, 2010).

To answer these questions, I analyzed video records of talk and activity over the various phases of GPS drawing—one mobile mapping activity—focusing on youth learning along lines they created and articulated. I also incorporated video of young people describing their participation in GPS drawing to urban planners and local stakeholders in a follow-up meeting. Building on a literacy framework that considers the array of inscriptional forms opened up by computational technologies (e.g., diSessa, 2000), the following list describes what kinds of reading and writing activities were inside the analytic unit of learning along lines:

- *Reading*: Understanding how someone would walk a message (in the form of a continuous line) through a place with a GPS device.
- *Writing*: Planning to walk a message (in the form of a continuous line) through the neighborhood with markers and paper maps.
- *Writing*: Walking a line through the neighborhood, with GPS device in hand, to create a message.
- *Reading*: Looking at others' lines, in a GIS software, they had walked (or biked) through familiar and unfamiliar places.
- *Reading*: Analyzing features of lines uploaded to a GIS software.
- *Writing*: Describing and narrating to an audience the lines they drew through the neighborhood.

Although other tasks in the locative literacies curriculum involved learning along lines, GPS drawing spanned all of these instantiations of learning along

lines, whereas other designed activities encapsulated just a few of these different instantiations. Therefore, I focus on GPS drawing to understand how youth participation looked *across* phases *within* a designed task.

After identifying moments of learning along lines, I developed categories of youth participation as youth learned about, planned, walked, and described their GPS drawings with one another and with adults. In doing this first pass of category development, I paid careful attention to the conceptual content of talk *and action* (e.g., posture, gaze, gesture, body position) in relation to technologies, the representations in use or produced (Lemke, 2009), and the geographic terrain of the neighborhood. Because a design objective of the study was to leverage the mundane experiences of physical and digital mobility as resources for learning locative literacies, I looked for similarities and differences between participation and engagement on the move (e.g., walking through the neighborhood) and participation in place (e.g., seated in a computer lab). For example, the historical associations young people had with their neighborhood were vibrant during on-the-move portions of the task, whereas these associations all but vanished during stationary phases of the task.

I used a grounded analysis approach (Strauss & Corbin, 1990; Glaser & Strauss, 1967) to iteratively describe, categorize, and compare aspects of how youth participation looked within the analytic unit of learning along lines. Using a digital media software for qualitative video analysis, I imported and then content logged the video files, inserting corresponding field notes. I identified times when young people were working collaboratively with tools, representations, and the neighborhood to make sense of the task. Because of the novelty of the mobile mapping activities, and the nature of how the tasks were designed, there were few instances in the video record when young people were *not* working collaboratively. However, there were instances when the tools and/or the maps faded away (e.g., while walking through the neighborhood, the girls began identifying houses in which attractive boys lived). These instances were not coded in relation to the research questions, though they were important moments for participants in maintaining a high level of play and engagement in the overall task. I began coding selected moments in ways that were succinctly representative of how youth participation looked in that moment.

After rounds of coding, I shared my interpretations with colleagues by showing representative episodes of learning along lines. I also applied these codes to other designed activities (e.g., historic neighborhood geocaching, ground truthing). This phase of analysis allowed me to better define codes (e.g., what is in and what is out of this kind of participation?) and consolidate codes. Across iterative cycles of coding, it became increasingly apparent how important the corporeal and affective qualities of learning along lines were for young people to engage meaningfully in locative literacy practices.

To avoid losing these embodied and often ephemeral qualities in my analysis, I began producing multimodal transcripts, paying close attention to how learning along lines was composed of talk, body position, gaze, gesture, and the environment, including artifacts and tools in use. I plotted the modal importance and density as it transpired in highlighted interactions (Norris, 2004) so that the shifting relations between different forms of communication were visible (Haddington & Keisanen, 2009). This multimodal transcript also included images of where young people were located in their neighborhood or in the workshop to get another, bird's-eye perspective on how the particular geography was influencing their coordinated activity since camera views can be myopic. An example of this analysis is shown in Figure 1. The first two columns (from left to right) show frames from the researcher's camera and the participant's head camera to give a sense of the action on the ground. The third column shows carefully transcribed talk, with bolded text denoting the turns of talk that align with the action from the video stills. The fourth column shows the shifting modal importance and configuration of the interaction: The larger the bubble, the more important that particular form of engagement was in the moment. The final column is an overhead perspective of the neighborhood where the interaction took place.

I then traced over time, through another round of coding, how the conceptual content of talk and action—especially in relation to the artifacts being produced—persisted, disappeared, or changed over the course of the task. I eventually developed 14 top-level codes to describe forms of youth participation in learning along lines. These were answering, challenging, explaining, following, generating ideas, highlighting, imagining, initiating collaboration, leading, negotiating inscriptions, noticing, providing alternatives, re-membering, and scaling. This process helped me to identify *new* forms of youth participation that were specific to locative literacies, like using location-aware tools in relation to their mobility through the neighborhood.

In this article, I use a microanalytic approach of hot spots (Jordan & Henderson, 1995) to highlight three forms of youth participation in learning along lines. The first form is *scaling*, or adjusting the activity to the distinctive affordances and constraints operating at a given scale (e.g., thinking about physical mobility as an inscription technique across the scale of the neighborhood, the mapped scale, and the constraints of the GPS device). The second form of participation is *negotiating inscriptions*, or compromising with one another, the technology, and the built environment to create a meaningful sign (e.g., Star & Griesemer, 1989) for a variety of audiences (e.g., throwing the GPS device over a fence to preserve the accuracy of the image). The third form of participation I highlight is *re-membering*, or discursively reinstating the

embodied effort (Michelson, 1998) involved in making the inscriptions through the neighborhood (e.g., recounting the hilly terrain traversed to make a letter).

I focus on these three forms of participation because they highlight how young people took up locative literacy practices with new technologies and representations within the context of a novel task. I was particularly interested in what resources young people used to make sense of designed tasks and how their collaborative work on the move informed, but contrasted with, more stationary teaching and learning configurations (i.e., walking through the neighborhood compared to sitting in a computer lab). In “Scaling” in the findings section, I discuss how young people scaled their activity to the task of walking a line through the neighborhood. In “Negotiating Inscriptions” in the findings section, I show how young people walking lines through the neighborhood coordinated many different modes of engagement to create an inscription. And finally, in “Re-Membering Lines” in the findings section, I demonstrate how adult-driven, stationary learning arrangements dissolved the multimodality of on-the-move formations so that young people had to re-member their embodied effort and collaboration in retrospective accounts.

A final note about the analysis: In my microanalyses of hot spots, I attempted to keep the affective and corporeal foregrounded for three reasons. First, these qualities of social phenomena are often lost in analysis and are therefore not conceptualized in accounts of learning. Second, seemingly ephemeral experiences in the moment proved to be lasting resources for young people’s inscription processes. Third, the analyses attempt to frame learning locative literacies as a distributed *process* rather than a moment decontextualized from time and place.

ANALYTIC FINDINGS

I use the activity of GPS drawing to explore a new analytic unit, learning along lines, as a tool to support the design and analysis of learning contexts where the leading mode of engagement for learners was physical and digital mobility through the city. The analyses are intended to push the field’s understanding of embodiment and digital mobility in conceptualizing accounts and designing new joint forms of learning locative literacies. In this section, I report my analysis of three forms of youth participation as they read, talked about, created, and analyzed lines through the neighborhood. These forms of participation are scaling, negotiating inscriptions, and re-membering during GPS drawing. For each form of participation, I first give an overview. I then go in depth into representative episodes focusing on the resources young people were able to take up and how learning along lines informed static, adult-driven learning arrangements and representations.

Scaling

Mobile mapping activities, including GPS drawing, were intentionally designed to operate across multiple scales—the scale of the body, the scale of the neighborhood, the map scale (both paper and digital), and the scale of the city. Marston, Woodard, and Jones (2009) wrote about such a process as “operat[ing] at multiple scales at once, and as a result, attention should be paid to their operational distinctiveness at particular scales and to the mechanisms that define their modifications from one resolution to the next” (p. 665). The lines participants planned, walked, analyzed, and viewed as part of the GPS drawing task connected and jumped scales (Cresswell, 2006). This quality necessitated that young people *scale* their physical mobility relative to these other scales and the various constraints and affordances operating at each of them. One scale was that of the neighborhood, which included various obstacles (e.g., fences, walls, houses). Another scale was that of the map and its various omissions (e.g., no elevation information). And yet another scale was that of the GPS device, which had a margin of error of ± 5 m. I argue that this quality of mobile mapping tasks (i.e., operation across multiple scales) supported young people to leverage their own bodies as a resource for learning locative literacies in coordination with representations, both paper based and digital.

Making Invisible Lines Visible. Coordinating across scales was an important step in being able to produce a narrative line through Woodbridge that was commensurate with mapping technologies. Because our (including me as the facilitator, adult researchers as participant observers, and bike workshop volunteers) talk and action traversed multiple geographic scales, the lived and the abstracted were in constant relation, albeit tense, to one another. As shown in the following episode, this productive tension between scales arose immediately in the introductory planning stages of GPS drawing as imagined and preliminary inscriptions were rescaled (Latour, 1987) to the room, to the map, and to the neighborhood. (Note that the episode begins with Carissa and Leah talking to each other while I was talking over them to the rest of the group.)

| | | |
|---|----------|--|
| 1 | Author: | Well, OK, let's talk about this. [What- |
| 2 | Carissa: | [OK, so what are we gonna do? |
| 3 | Author: | [Use- |
| 4 | Leah: | [I love you. |
| 5 | Author: | OK, so we're gonna use the GPS devices, [right?] |
| 6 | Carissa: | [How] can [we make] that in a path like that? |
| 7 | William: | [Hm-hm.] |
| 8 | Leah: | [Like that.] ((Draws path with finger on map that Carissa is holding)) |

The episode begins with Carissa and Leah already making *plans*, “bringing into perspective the goals and methods required for accomplishing some task” (Murphy, 2011, p. 246). They were not just eager to begin the work of GPS drawing, they were also stepping into, at this point, the imaginary scale of the neighborhood by looking at a satellite map. At Turn 2 Carissa initiated work on the task, and Leah at Turn 4 offered her idea to write the words “I love you” through the neighborhood. As the facilitator, I continued to set up the task with the group (at least with those who were listening) while Carissa questioned Leah about the scaling possibilities of turning that message into a “path” (Turn 6) or, for the purposes of this article, a line. With her index finger, Leah traced the message over the map to show Carissa how the words could be turned into a continuous line through the neighborhood. In this way, the satellite map and Leah’s trace act as “local metrics” (Goodwin, 2003, p. 323)—proxies available at the scale of the interaction—standing in for the neighborhood and walking with the GPS device, respectively. In other words, through Leah’s efforts, the line she imagines walking becomes visible, even though they are stationary, seated or standing, around a map. In his analysis of professionals at work, Keith Murphy (2011) described architects engaged in an analogous process of using local metrics to convince collaborators of the feasibility of scaling a plan to the real world. This strategy worked for Leah, as her collaborators, Carissa and Beth, would eventually walk the word *LOVE* over five neighborhood blocks.

Scaling across the body, the device, the map, and the neighborhood was not always straightforward and necessitated moments of spatial problem solving, especially with this unfamiliar technology (i.e., GPS devices). In these moments, bodies became important resources for making sense across scales and, more important, for making one’s sense-making process visible to others. In the episode that follows, the group was having trouble *translating* the experience of drawing with pen at paper scale to drawing with a GPS device at the neighborhood scale.

I introduced the idea (though not too clearly) that the scale of their inscriptions (i.e., the image or word they would walk with GPS device in hand) was related to the scale of the neighborhood (Turn 9). Had I thoughtfully planned a discussion on scale beforehand, I probably would not have used the word *accurate* as emphatically as I did. In retrospect, focusing on scale as a concept in the Wood drawings first and then talking about how the issue of scale related to walking around with a GPS device to draw or write would have helped me better understand how the youth were using scale before and after doing this activity. But, as it was, at least William, Wallace, Carissa, and Leah seemed to initially agree that walking and writing at a small scale would produce a less “complicated” word or image (Turn 10).

9 Author: Is [it going to be]- is it gonna be more accurate, if it's BIGger? If it- if tha scale is bigger, like you use more of the neighborhood? Or is it gonna be more accurate if it's smaller do you think?

10 Wallace, William, Leah: Smaller.

Leah:

11 Author: Why?

12 Leah: 'Cause it's easier. Like if- *((steps away from table, puts feet together and draws a box around her feet))* if it was like this big, you'd just go like that *((takes two steps forward))*. Which, if it's huge *((turns to her right and takes four steps))* you gotta walk all the way up here *((turns around and comes back to table))* and it's [too complicated.]



13 William: [And you might get] lost.

14 Author: Oka:y.

15 Wallace: And forget.

16 Carissa: And then there's a chance you might kinda drift off [to the side a little bit ()].

17 William: [Like if you could- if you were gonna write "I,"]

18 Author: Uh-huh. =

19 William: =*((Traces lines with index finger on map of neighborhood))* You could go up here and then turn, and turn on THIS one instead of going all the way up here, and doing all that.

Leah and Fred seemed to agree, too, that the smaller the inscription, the less effort it would require. Leah's logic behind this answer was given first (Turn 12). If Leah's response was representative of the group, the youth thought, like in drawing a straight line at paper scale, there was less chance for error or veering off course if one made the line very short.

Leah's response was logical and translated her experience of drawing with pen at paper scale to drawing with a GPS device at the neighborhood scale. But her answer was remarkable for a different reason. The way Leah answered the question demonstrated how, even in a comparatively "schooled," adult-driven moment of interaction, a norm had been established by this point in the study (our seventh meeting) that bodies—more important, *moving bodies*—were an important resource in the work we were doing together. The scale of the body was just as legitimate as that of the map. Moving bodies were even part of answering questions; Leah walked two different versions of a line to make a sensible response to the question I posed about appropriate scale (see Figure 2). She showed what she meant by walking a very short line forward in three small steps (simple and accurate) versus walking across the room in four giant steps (complicated and inaccurate). She focused her gaze on the ground and her feet rather than referencing the map that was inches from her face. Leah's words alone were sensible, but they could not stand alone, separate from the action she was performing with her body. The "this" and "that" to which Leah was referring could only be indexed to the box she drew around her feet and the steps she took toward the table.

Leah produced a scaled-down, inside version of the neighborhood, already imagining herself outside writing/walking with a GPS device. But while Leah demonstrated a small, effortless, and accurate drawing, William (Turn 13) touched on a different problem that is not present in the familiar activity of writing with pen. William and Wallace (Turn 15) were concerned with the *invisibility* of the line they would be making while on foot and how this invisibility could easily cause problems related to accuracy. They "might get lost" in their own inscription. Unlike Leah, who scaled her response to her own body walking the neighborhood and ignored the map, William returned to map scale to provide further explanation. William scaled his answer and the mobile body to the map, tracing an imaginary pathway with the tip of his finger to show a simpler version of a more complicated way to inscribe the letter *I* (Turn 19).

Coordinating talk and action across scales for inscribing a line through Woodbridge supported youth to access a variety of resources. Although all of us had to understand the constraints at various scales, we were also able to pull from the various affordances operating at each scale. This was true in the episode that follows, in which I used an iconic feature of the urban landscape, the city block, as a resource for collaboratively making sense of the task.

-
- 20 Author: ((*Holds two Jeremy Wood drawings in hands*)) Look at this scale. Is this a big scale or a small scale?
- 21 William: [Big.
- 22 Leah: [That] is a [hu:ge sca]le.
- 23 Carissa: [Big scale.]
- 24 Fred: That's hard. ((*Smirking*))
- 25 William: That's a [big scale.]
- 26 Fred: [()]
- 27 Leah: [That took forever.]
- 28 Author: [Is that multiple city] blocks, or-
- 29 William: Multiple.
- 30 Author: Yeah.
- 31 Leah: Dang, that-
-

I invited the youth back into the scale of Jeremy Wood's drawing of the dollar sign through Las Vegas, the base layer of which was a satellite photo (gpsdrawing.com/gallery/land/usa/nv/vegas_dollar.htm). When I asked them to consider this as either "a big scale or a small scale," they immediately and synchronously identified the scale as "big" or even "huge" (Turn 22). Fred and Leah quickly temporalized and embodied (i.e., drawing at this scale would require an enormous amount of time and physical exertion) the meaning of "big scale" in relation to this activity by saying, "That took forever" (Turn 28) to walk. I asked them to further scale their responses to "city blocks," an attribute that was easily visible on the map of the Woodbridge neighborhood they were holding. City blocks were also a common measure of distance for these urban pedestrians. Using city blocks as a scaling device was a way to attenuate the scale of the map with the scale of the body and the walkable neighborhood.

Summary. By this point in the task, the young participants had made and learned along three lines: First, Leah had *traced* a message over the neighborhood. Second, Leah had *walked* a short and a long line to show the relationship between scale and accuracy. And third, William had iconically *traced* a line into existence onto the map of Woodbridge. Everyone else's gaze followed the action. These lines of learning locative literacies also represented how engagement and understanding were moving across scales: Leah was making sense at the scale of the map first and then the body, and William was grappling with the task at the scale of the map after watching Leah's embodied performance.

My invitation to consider the scale of Jeremy Wood's drawings caused all of the participants to change their stance on drawing at a small scale. Judging from their planned and produced images in the following phases, the youth emerged from this discussion with an understanding that bodies, mediating representations, and technologies support and operate at particular scales and that these scales are relational. For

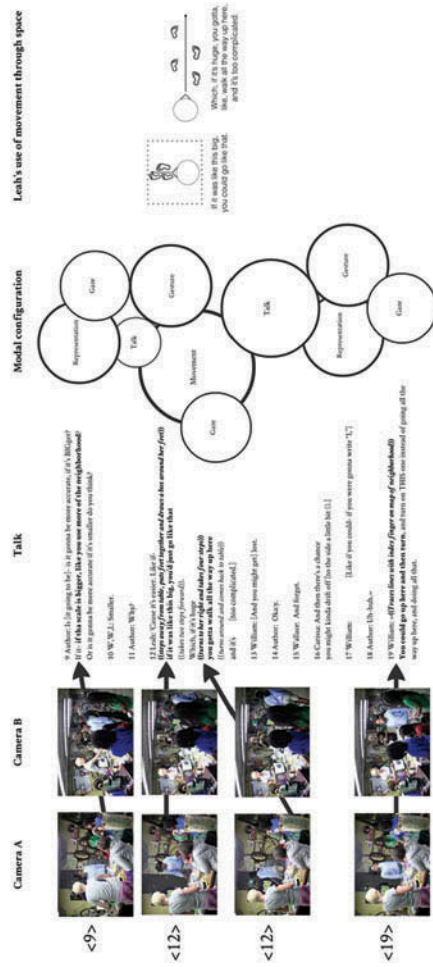


FIGURE 2 Leah walks two different lines to demonstrate her understanding of the relationship between accuracy and scale. As the interaction proceeds, the fourth column shows the modal configuration shifting over time from looking at the map, to movement, and back to the map and eye gaze. W.W.L = Wallace, William, Leah.

example, one's body might prefer to walk at a small scale because of the heat, because feet get tired, and because the cicadas are out in full force (as was the case on this muggy June day). In contrast, GPS devices function better at a larger scale than what one's body might prefer to undertake. Furthermore, the scale of the map does not show obstacles that a pedestrian might encounter along the way.

In learning along lines, these six participants took up various communicative capacities of their bodies, like walking, gesturing, and gaze, to make and coconstruct meaning of the activity. But they also used maps of their neighborhood and one another's spoken contributions from which to build an operational understanding of scale. Before this activity, the "operational distinctiveness at particular scales" (Marston et al., 2009, p. 665), especially that of the GPS device, was unfamiliar to the group. However, when the time came, each group successfully created a GPS drawing through the neighborhood.

Even though this part of the activity was contained within a room—the basement of the Woodbridge youth-serving organization—the participants were already planning, imagining themselves constructing a word or image outside through the city streets. By scaling what they would coauthor in the immediate future in a neighborhood they knew well, Leah, William, Wallace, and Carissa in particular were accessing resources that learners do not typically access for tasks that are stationary and located in settings that could be characterized as *nonaffinity spaces* (e.g., classrooms).

Negotiating Inscriptions

Mobile mapping tasks, including GPS drawing, supported youth to make a *cascade* of inscriptions (Latour, 1987). Scaling a line on a map to a walked line through the neighborhood and then to an animated digital line in Google Earth™ had an iterative effect so that young people encountered their lines in relation to the other instantiations, within different settings. However, at each scale, whether it was drawing, walking, or viewing, inscribing lines through the neighborhood was a negotiation. Young people had to compromise with one another, the technology, the built environment, and their memories of the different phases to make a sensible inscription that would preserve its internal relations on the move (Star & Griesemer, 1989), between the workshop, the neighborhood, and the computer lab. As young people's inscriptions moved to different contexts, a different set of negotiations became necessary and new resources became available for making sense of the message or image. This cascading quality of the designed tasks opened up opportunities for the young people to jointly express a biographical, affective attachment to the neighborhood via representations and mapping tools.

Walking Lines. Inscribing lines on foot highlighted the ways in which technology, maps, bodies, individuals' roles, affect, and the terrain were held

in tenuous relation to one another as young people learned along lines. These relations were constantly under negotiation.

It is important to note that for both groups, inscribing a line (on foot) through the neighborhood was a compromise with the changing terrain. It was possible to track the changing terrain through changes in participants' talk as they walked. Topics relating to their locations included, but were not limited to, cicadas, the lack of sidewalks, running out of breath, being hot, being tired, the rainy weather, music videos, cute boys living in the neighborhood, bad drivers, drinking soda, a girl in "booty shorts," and dozens more (see Figure 3 for changes in talk over time).

Negotiating these (walked) lines into existence was a joint accomplishment. With GPS devices and maps in hand, negotiating inscriptions held their bodies together in coordinated activity that elevated their pulses, fleetingly brought neighborhood residents into the interaction, sent them careening down hills on their bottoms, and elicited reactions from all of the senses (even taste, as some of the teens carried sodas or excitedly found forgotten snacks in their pockets).

Even though the mobility of the scribe, or the person wearing the GPS device, was the only movement that actually mattered for the creation of the image or word, all of the teens walked the planned routes as a formation. Not one group decided to send the scribe down a dangerous, slippery slope alone or up a steep hill while the others stood back and watched or took the easy way around. Therefore, learning along lines was jointly accomplished through a familiar landscape in which bodies were engaged and held to one another in a place already teeming with action, memories, and sensation. This joint (though not easy) accomplishment is demonstrated in the following episode.

-
- 1 Carissa: That's a big hill! Oh, man. ((*breathing heavily*))
 - 2 Kris: You didn't see THAT in the map, did ya?
 - 3 Carissa: No. =
 - 4 Leah: =Uh-uh, we need to get there, then- nah, 'cause that ain't gonna look right. Ugh. I told
you you shoulda [let us-
 - 5 Beth: [This is a slippery hill! =
 - 6 Leah: =We can go straight, [it will still be a V.
 - 7 Carissa: ((*running down hill*)) [AHHHHHHHHH
 - 8 Beth: ((*falls on bottom and slides down hill, laughing*))
 - 9 Jill: O[oo.
 - 10 Sam: [Hahahaha]
 - 11 Jill: [Careful.]
 - 12 Kris: [You alright,] Beth?
 - 13 Leah: Beth, you always fallin'. Oh, I gotta be the one to-((*squats and slides down hill*)) Ugh,
ugh.
 - 14 Beth: ((*continues laughing*))
 - 15 Jill: ((*laughter*))
 - 16 Leah: That was terrible =
 - 17 Beth: =That was slippery.
 - 18 Carissa: Ok. ((*still breathing heavily*))
-

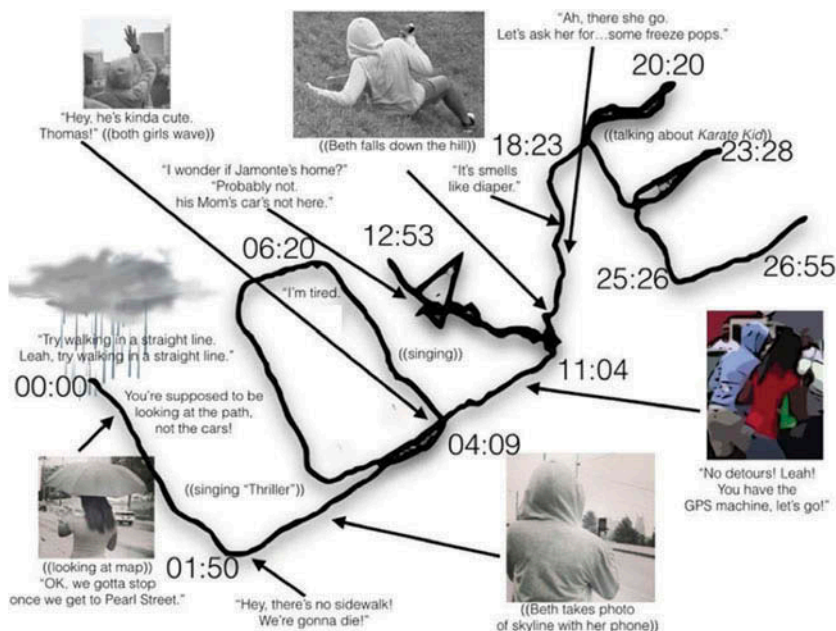


FIGURE 3 Within the activity structure of global positioning system drawing, moving through the changing environment elicited shifts in participants' talk and focus. This image shows a sample of the girls' talk-in-action as they inscribed the word *LOVE* over five blocks of the neighborhood. GPS = global positioning system.

In making the *V* in *LOVE*, the girls ran into unanticipated trouble caused by the three-dimensionality of the terrain. Neither the map nor the line they drew in the planning phase considered hills and slippery grass, as Kris pointed out to Carissa (Turn 2). Carissa's shortness of breath was the most audible consequence of this variability in the terrain because she was wearing the lapel microphone; her heavy breathing was a constant rhythm in the video record. Once Leah saw the steepness of the hill that lay in their path, she did some quick problem solving. Leah suggested an alternative route that would still, in her estimation, produce the right arm of the *V* (Turn 6). Carissa could not be deterred, however, and with Beth at her side and clipboard in hand marched forward on (or down) their planned course. Even though the only person's mobility that actually mattered for the GPS drawing was Leah's, all three girls put the cleanness of their backsides in peril by traversing down the slippery slope of the *V*. This decision proved most consequential for Beth, who fell and slid a few feet on her bottom down the hill with soda can still in hand (see Figure 4, Frames –). Even though Beth did little more than giggle, the reaction to her fall from the rest of the group

(laughter and concern) ensured that this event would be an occasion for *re-membering* later in sharing this GPS drawing with others.

Leah considered the fall typical of Beth (Turn 13) but quickly realized that she too had to traverse the same path and might meet the same fate. Even though she wanted to go around the flatter part, as she suggested earlier, the line they were walking connected her to the other girls and pulled her down the hill (Frame, Figure 4). As she begrudgingly and noisily followed the path, Carissa and Beth turned back to watch and wait on her to catch up (Frame, Figure 4) and fall back into formation. When the three adult researchers violated the coordinated effort of the activity, Leah was quick to call them out for it (Turn 19 below).

| | | |
|----|----------|--|
| 19 | Leah: | ((<i>looking at adults</i>)) Ah, and [they get to walk around.] |
| 20 | Sam: | [Y'all did great. Keep it] up! |
| 21 | Jo: | ((<i>laughing</i>)) |
| 22 | Beth: | Hold up! I gotta walk [around] the poop! ((<i>laughing</i>)) |
| 23 | Carissa: | [U::gh.]Leah give me tha thing! |
| 24 | Leah: | I got it. |
| 25 | Carissa: | 'Cause you- |
| 26 | Leah: | Oh, I'm sca::red. |
| 27 | Carissa: | Huh. ((<i>still breathing heavily</i>)) |
| 28 | Beth: | ((<i>squeals</i>)) |
| 29 | Carissa: | ((<i>walking up hill</i>)) Huh. |
| 30 | Leah: | I am not trying to die before I go (.),[before I le:ave] |
| 31 | Beth: | [Uh, there's dog] poop over here! ((<i>laughing</i>)) |
| 32 | Leah: | I can die when I come back, but not right now. |
| 33 | Beth: | Ah, here she go. Let's ask her for them- for free- some freeze pops. |
| 34 | Leah: | She doesn't even sell those things no more. It's been like 3 years. |
| 35 | Beth: | ((<i>giggling</i>)) |
| 36 | Leah: | It has! |
| 37 | Beth: | I know. |

Throughout the walk, the presence of the GPS device repeatedly resurfaced as yet another agent coauthoring this new line through Woodbridge. As part of the walking formation, the device on Leah's wrist caused much ire between her and Carissa. Throughout the trek, Carissa doubted Leah's commitment to her job as the scribe. On several occasions, Carissa demanded that Leah give her the GPS device so that she could be in charge of what was being written over the neighborhood. For example, a few minutes before making the *V*, the girls passed a family in the driveway of a house that the girls knew well. The parents and an older man stood outside the car and two youth that Leah and Carissa knew were sitting in the car. Leah left the formation to

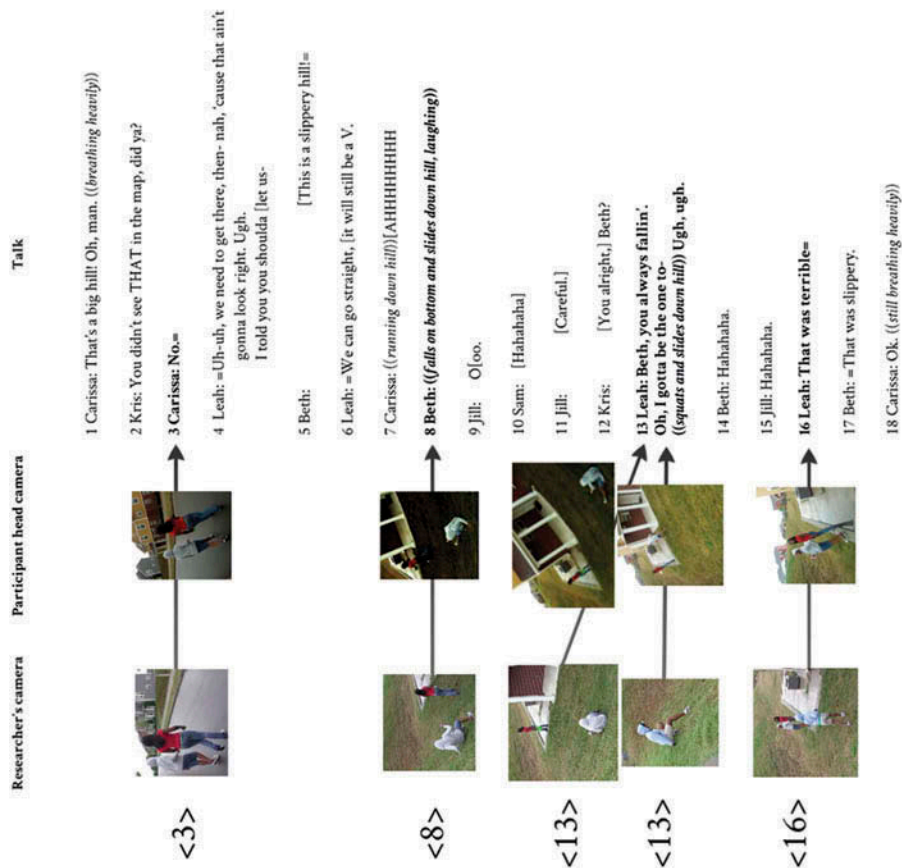


FIGURE 4 Frames from the researcher's and participant's cameras; action coinciding with turns of transcribed talk.

stop and chat with the young people in the car, and Carissa began regulating the position of Leah's body to fall back into the formation of the line. Carissa exclaimed dramatically, "Hey! No detours! Leah! Leah!" Carissa walked up behind Leah, grabbed a handful of Leah's sweatshirt, pulled her away from the car, and yelled, "You have the GPS machine! Let's go!" (see Figure 3, at time stamp 11:04). Each time Carissa scolded Leah or demanded the GPS device (e.g., Turn 23), Leah refused her (Turn 24) and fell back in line to do her job.

These on-the-move negotiations were responsible for the shifting modal configuration of the activity. As shown in the previous episode, as soon as perceived threats to the body dissipated, georeferenced stories and memories resumed. After the girls topped the steep hill, Beth looked over to her left and recognized the apartment they were passing as the residence of a familiar person. Her spatial association was one related to a woman who used to sell "freeze pops" to the neighborhood kids. Beth even suggested, probably jokingly, that the girls should stop and ask for one. Leah remembered the woman too but insisted that she had not sold "those things" in "like 3 years" (Turn 34). Beth giggled and eventually agreed with Leah that she was right.

Summary. Locative literacy tasks involved much more than walking a negotiated route through the neighborhood. Instead, as a walking formation, young people and the researchers who were with them produced new, dynamic inscriptions that coordinated memories, bodily sensations, fear, surprise, maps, and technology. Some places along the walked lines were locations they had been many times before. Other places were new because they had never walked this particular route to get to locations. Learning along (walked) lines especially created an opportunity for grounding the task in a new spatiotemporal ordering and layering of stories that spanned the past and present. In this way, learning along lines coordinated different resources (e.g., memories, neighbor associations, desires) for making sense of a newly mediated form of mobility with location-aware tools and representations.

By this point in the designed task of GPS drawing, learning along lines had manifested in different settings and at different scales from being in the workshop and gesturing and tracing lines into existence to being in the neighborhood and walking lines into existence. Each instantiation afforded new resources to leverage and also new constraints for reading and writing a story about being a young person in this mobility desert. As described in the next section, the walking phase too was essential for youth to make sense of their inscriptions for different audiences in the viewing and sharing phases of the task.

Re-Membering Lines

It is not surprising that sharing and critiquing one another's inscriptions in a GIS differed dramatically from the phases of planning and making lines. Across tasks,

compared to the (literal) liveliness of the planning and making/doing phases, the viewing and sharing phases were much more about the representation, understanding what could or could not be seen and critiqued from a bird's-eye view of an animated, digital inscription. Nevertheless, youth found ways to *re-member* the line by discursively reinstating the embodied effort involved in making the inscriptions through the neighborhood. They made visible what the mapped lines hid—their physical effort in relation to a changing neighborhood terrain—and expressed frustration that the represented lines were not able to show that effort and, worse, made mistakes in accurately portraying their embodied lines. In this way, viewing and sharing their inscriptions in Google Earth “uniquely engage[d] [young people], not as disembodied voyeurs, but as participants in global dialog, represented spatially on the digital map” (Farman, 2010, p. 870). In their recounting with one another and with adults, youth animatedly re-membered the embodied effort making these novel lines through Woodbridge required and also how this new form of mobility—that of creating inscriptions in coordination with GPS technology and one another—was often in contradiction with the built infrastructure, including parking lots, houses, and designed elevation changes. Re-membering the digital inscriptions was a form of democratizing maps and mapmaking to include multiple points of view on the authoring process (Monmonier, 1996).

The Scale of Doing Versus the Scale of Viewing. At the scale of viewing their tracks (a GPS device term for the recorded pathways from the devices that were uploaded into Google Earth™), youth experienced their inscriptions in a truly different modality than what they had experienced on foot or with a map and pen. As mentioned previously, because youth could not see their inscription in situ, the animated path that flashed onto the screen in the order they walked it was at first a version of “seeing everything from nowhere” (Haraway, 1991, p. 189). Youth had to discursively re-member the lines they had planned and walked in previous phases to understand these tracks and communicate their importance to one another and adults. As in the episode that follows, participants talked through how they planned and created the inscription; what challenges they faced; and how planning with a map compared to actually walking the inscription through streets, sidewalks, yards, trees, and parked cars and over hills. This process of re-membering created space for multiple perspectives on the now digital lines.

In the illustrative episode that follows, Leah, Carissa, and Beth were reading their complete GPS drawing for the first time. The word *LOVE* was being projected as a data layer on top of a satellite map of Woodbridge. (See Figure 5 for an image of what was being projected at the front of the room.) The room also contained their peers, adult workshop volunteers, and several researchers. At my prompting, the girls were describing how they made their GPS drawing and what challenges they faced. Leah began



FIGURE 5 Each image is an edited screenshot corresponding to a numbered turn of talk (numbers in the upper left corner). Areas of each frame are highlighted with a circle to show where Leah was attending to errors in the global positioning system record.

operating the computer at the front of the room at Turn 2 and so was highlighting points on the line with the cursor of the mouse as she talked about them (highlighted by circles in Figure 5). At Turn 15, Kris took back control of the mouse.

-
- 1 Author: Hey, uh, Leah. Why don't you g::o, s-stand next to Kris and letsss-tell her where to- where you want to point the mouse, or you use the mouse and show us what you're talking about.
- 2 Leah: ((*Gets up from desk, walks over to computer and grabs mouse.*)) That little piece right here- ((*moves mouse over the top of the V*)) that little triangle piece, we never went over there.
- 3 Author: Ok.
- 4 Leah: I don't know why it did that.
- 5 Author: So that's just an error, you think?
- 6 Leah & Yeah.
- Carissa:
- 7 Author: Ok. Ok. So what's a challenge that you guys faced?
- 8 Leah: That uh- that E. Cause we had to go- we had to cross- oh.
- 9 Author: Yeah, show us on tha-
- 10 Leah: ((*Moving mouse around to highlight places on the screen*)) We had to cross over right here, then we had to go back, and go down, over, come back, go down go over, come back. And then-
- 11 Author: So, was something in your WAY, is that what you're saying?
- 12 Leah: No, it was just a lot of walking.
- 13 Author: Oh, it was a lot of walking?((*looks over to Carissa who has her hand raised and points to her*))Yeah, Carissa.
- 14 Carissa: Um, the hardest part that I thought it was was the V 'cause, of course on the map, everything looks all flat, but then when you start walking up there, there's a bunch of [hills and houses and-
- 15 Kris: ((*zooms in to arm of V*)) [so what happened here? = ((*moves mouse over a dip in the line*))
- 16 Carissa: =And all that. Um, see yeah, that was a big hill right there that we had to go up =
- 17 Leah: =There go some more errors! We never went through them trees!
-

Leah and Carissa discursively re-membered parts of the lines they walked through Woodbridge in their effort to write the word *LOVE* over the neighborhood. Both of them attempted to re-member the bodily effort required to walk this far with lots of backtracking in making the letter *E* (Turns 8–12) and steep hills in making the letter *V* (Turns 14–16). In being able to view their GPS drawing, they quickly recognized that this digital representation was far from a complete mapping of their process, which

involved sweating, heavy breathing, and falling down hills. Carissa articulated this tension between what the map showed *of* the neighborhood and what the body felt *in* the neighborhood when she stated "... of course, on the map everything looks all flat, but then when you start walking up there, there's a bunch of hills and houses ..." (Turn 14). Leah especially was disappointed by the technology's inaccuracies, perhaps because she was the one holding the GPS device for the duration of their walk and had a lot of pressure from Carissa to perform her job well.

Re-membering the body's effort back into the digital inscriptions was also an important part of the design charrettes with urban planners and local stakeholders held several months later. In the following episode, Carissa and Leah described their effort as "NOT easy."

-
- 1 Carissa: First we just drew our idea on a map, and then we went out and did it. ((*Pointing to GPS drawing projected on screen*)) But this was NOT easy
- 2 Room: ((*laughter*))
- 3 Carissa: because we couldn't separate the letters-
- 4 Leah: We had to walk =
- 5 Carissa: =Yeah, we had to walk
- 6 Leah: Up hills
- 7 Carissa: Yeah, again- on the same spot over and over again. And that V was not easy 'cause we had to dodge cars and apartments. That's why it's all squiggly ((*pointing to GPS drawing projected on screen*)). And yeah, it was- yeah, it was, pretty-
- 8 Author: So you had to- you basically had to deal with what was there on the ground
- 9 Carissa: Yeah, it wasn't very fun because I can't walk through walls.
-

Young participants expressed their frustration with the *experience* of walking their inscriptions and seeing little of that embodied effort reflected in the GPS trace on the map now visible to a captive audience. For example, Carissa described GPS drawing as neither "easy" (Turn 1) nor "fun" (Turn 9). Leah eagerly pointed out how the challenging topography was omitted from the map (Turns 4 and 6). The audience was also unable to see the cars and some apartment buildings that were obstacles to creating their inscription, and knowing about these obstacles provided an explanation for why the letter *V* was "squiggly" (Turn 7). In their discursive re-membering of the line they walked through the neighborhood, Carissa and Leah exposed their understanding that maps and location-aware data, like all inscriptional forms, have not only narrative power but narrative limitations as well.

Summary. Being able to discursively re-member these inscriptions over novel representations of their community—maps layered with collaboratively produced track data from walking a message over the neighborhood—was a learned skill, and youth got better at this over the course of the study. As is characteristic of scientific practice, young people re-membering their mapping processes rendered new forms of knowledge—new writings of the city—that bridged the “disconnection between the observer and the observation” (Hatcher, Bartlett, Marshall, & Marshall, 2009, p. 142). Sensuous memories attenuated the privileged position of data for understanding life in the city.

Analyzing learning along lines across different phases of GPS drawing revealed that youth leveraged different resources for understanding a newly mediated form of mobility and communicating with one another and with interested adult stakeholders. Seeing traces of one’s mobility over a satellite image with an interested audience proved to be a novel and engaging experience for participants. Across almost all of the instantiations of learning along lines, their embodied experiences, as well as their histories and imagined futures within Woodbridge, remained dominant resources for producing an account of being a young person in Woodbridge. Given my design objectives to make the embodied and affective experiences of Woodbridge youth commensurate with the traditionally quantitative affordances of location-aware technologies, I was pleased to find that the corporeal and collaborative nature of GPS drawing persisted all the way to the sharing phases with adults. The teens’ creations were beautiful, eliciting emotional responses and telling true-to-life stories of loving one’s home and time going by slowly in school. Over time, youth lost their naiveté with not just maps but the tools that make maps as well and began to expect and use these inaccuracies as fodder for playfulness and imagination.

DISCUSSION

This article explored a new analytic unit—learning along lines—to understand how mobile and location-aware technologies open up new digital literacies for young people to read and write their own city. Learning along lines was a tool to support the design and analysis of learning contexts where the leading mode of engagement was physical and technological mobility through the city. As a contribution to the field of learning sciences, the findings of this work represent young people participating in an emerging terrain of digital literacies that are mobile, embodied, geospatial, and participatory; young people learned how to use mobile, location-aware technologies on the move through their neighborhood to represent a uniquely youth-centric experience of a place. Thinking about literacies as placed resources (Prinsloo & Roswell, 2012), participants’

compositions with GPS devices were fundamentally influenced by the particular geography of the neighborhood and their local experiences within that place. Reading and writing the city was a projection of their social reality (Bourdieu, 1984).

Following youth learning along lines across mobile mapping tasks allowed me to build “a more fully relational perspective on mobility and learning” (Leander, Phillips, & Taylor, 2010, p. 335) that accounted for continuity across contexts. By analyzing learning along lines, I found that youth were able to coconstruct new processes of mapping in which the more qualitative, mobile, and corporeal experiences of place informed quantitative, static, and abstracted accounts of space. Learning along lines created opportunities for participants to use their bodies, their lived experiences, stories about their own neighborhood, and one another to engage in new forms of digital literacy with mobile and location-aware technologies. Writing, as physical movement through a familiar place, primed young people to find meaning in the abstraction (Hostetter & Alibali, 2008) they would later read. The ways in which youth participated over time are consistent with Lindgren and Johnson-Glenberg’s (2013) view on embodied learning, that “when the appropriate sensorimotor systems are engaged, the converging inputs can create stronger and more stable memory traces and knowledge representations” (p. 446). But more to the social point on this cognitive view of embodied learning is that “Othered” bodies (e.g., Magnet & Rodgers, 2012, p. 107)—Black, adolescent, and living in the inner city—were a *resource* for creating memory traces and representations that had yet to be written into the official narrative of Woodbridge. Thus, the work here challenges current theories of embodied learning to account for both the spaces through which people live and travel and the ways in which “the body is rendered ... a visual display or text readable to an outsider’s gaze” (Lefebvre, 1991; Nespor, 1997, p. 121). Learning along lines foregrounds humans not merely as consumers or generators of texts but as being part of that text, literacy agents of a text they populate.

This study confirms that being on the move through neighborhoods and communities with location-aware technologies as mobile, sensing bodies is a valuable form of learning locative digital literacies; these modalities support different kinds of resources to be taken up in participating in an emerging “set of cultural competencies and social skills” (Jenkins, Purushotma, Weigel, Clinton, & Robison, 2009, p. 4) in the digital age. Youth in this study were able not only to understand mapping as a process of abstraction but also to think critically about abstraction as an epistemic move that is almost always black-boxed for the viewer. Had youth not produced their own lines through Woodbridge, whether through walking, gesturing, or re-memembering, the onerous process of data generation for mapping would have remained out of touch for these young

learners. I admit that making learning a mobile process that fundamentally relies on the capacities of the body is not easy for educators and facilitators, especially for large groups of learners. But with the affordances of this approach in mind, leveraging bodies-in-place as a learning resource is still undervalued and underutilized in more traditional learning arrangements.

As contributing to a genre of learning environments with technology, this work provides another example of a mobile augmented reality (MAR) design. MAR experiences use a digital interface on a mobile device to re-mediate a user's location in and experience of a place (e.g., Heinrich, Thomas, Mueller, & Sandor, 2008; Rothfarb, 2011; Ryokai & Agogino, 2013). Like the designed activities in this study, MAR experiences are multimodal, engaging all of the senses of the body while leveraging the presence of digital information quite literally in the palm of one's hand. Some MAR tools have been used to provide young learners with an expert's perspective on the environment. As students move through an area, a professional (e.g., a conservationist biologist) populates the digital interface to highlight aspects of the terrain that are representative of his or her respective professional vision (Goodwin, 1994). GPS drawing, however, shifts relations of expertise to elicit and represent young people's experience of a place on their own terms. In this study, a youth vision of the community was highlighted for professional planners and other adult experts.

The novelty and future-leaning nature of the mobile mapping tasks in this design study supported imagination to be "the guiding cognitive engine at work" (Murphy, 2011, p. 246) so that young people felt particularly free to write a geospatial narrative that was personal to their own experience of Woodbridge. At times, youth were frustrated with the reductive power of planning, walking, and viewing their inscriptions within a Cartesian grid (Hemment, 2006). The "authorial structure" of maps, including GIS (Farman, 2010, p. 869), prompted youth to find ways of using and re-membering their bodies-in-place during planning and post hoc accounts of the activity with adult audiences. In these final phases of sharing, young people synthetically layered their biographical experiences and their desires for the future on top of a map of the community to create a personal cartography of Woodbridge (e.g., Soja, 1989). These future desires included new bicycle lanes and better routes of connectivity to areas just beyond the boundaries of Woodbridge. Several of these youth recommendations were realized within the next year of on-the-ground community improvement projects (Taylor & Hall, 2013).

As a participatory literacy, learning locative digital literacies along lines also supported youth in disrupting a process of community planning that has historically positioned youth as victims of, or victimizing, community health. The benefits and lasting consequences of this learning arrangement, in which youth were eventually positioned as *teachers* of a unique community experience, made

the endeavor worthwhile. Coordinating encounters during which youth could share their inscriptions with urban planners, cartographers, city government officials, and Woodbridge stakeholders became a new practice in a citywide planning effort in the months following this study (see Taylor, 2013).

Mobile, location-aware technologies had yet to be adopted in the city's efforts to engage young people in mapping practices at the time this study was being analyzed. Although these tools, like GPS devices, undoubtedly bridge daily experience with the power of communicating via maps for nonprofessionals, there are still barriers to adopting them at city scale. The cost and manpower to save, sort, and analyze the data potentially generated by the public using commercially available mapping tools in community-wide planning endeavors are inconveniences that still outweigh the richness of information that could be produced. Still, this study shows that leveraging new technologies is an integral part of engaging young people in locative digital literacies so that they can produce new forms of neighborhood and community knowledge through moving through *and* representing the world.

Learning along lines, as explored through GPS drawing here, was one way of seeing and showing an intimately familiar place in a new way with one another and technologies. But even more important, learning along lines was also a way for young people to *teach* professionals and Woodbridge residents and stakeholders about a youth experience of place that had previously been ignored or constructed from a grownup perspective. This change in doing business as usual in community planning efforts was one step closer to realizing one's right to the city (Harvey, 2008) for Woodbridge youth and an essential final step in writing a story of Woodbridge as a mobility oasis rather than a mobility desert.

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