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Cara Courage, Tom Borrup, Maria Rosario Jackson, Kylie Legge, Anita McKeown, Louise Platt, Jason Schupbach

Sensing our streets

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Sean Peacock, Aare Puussaar, Clara Crivellaro

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SENSING OUR STREETS
Involving children in making people-centred smart cities

Sean Peacock, Aare Puussaar, and Clara Crivellaro

Introduction
Digital technologies pose significant opportunities and challenges for the future of urban life. Many regeneration schemes now come packaged as ‘smart city’ programmes, which integrate Internet of Things (IoT), sensor technologies, and data collection devices into the urban fabric to guide city officials in making their decisions (Karvon et al., 2018). However, these programmes have been criticised due to their limited potential for transforming socioeconomic conditions, threats to privacy and public space, and their top-down imposition on communities (Cardullo and Kitchin, 2018; van Zoonen, 2016). Such criticism has pushed scholars and practitioners developing processes and systems to critically engage citizens in the visions and technologies driving the smart city agenda and open up civic participation in shaping the way smart technologies could improve cities (Foth, 2017; Fredericks et al., 2018; Hunter et al., 2018). Here, we are concerned with children's participation and the significance of engaging children with smart technologies, to prepare them for inheriting smarter cities and equip them with the tools to hold decision-makers to account.

In this chapter, we ask: how can we critically engage children with smart technologies and through this support their participation in placemaking? Building on our recent work (Heath et al., 2019; Peacock et al., 2018) we collectively define placemaking as a practice of reimagining public spaces with the input of citizens. Here, we report on a pilot engagement that took place in a primary school in Newcastle upon Tyne, UK, that we designed for children to engage critically with smart city tools. Drawing on literature from placemaking, urban planning, and Human–Computer Interaction (HCI), we provide rich qualitative insights and methodological reflections from our engagement and offer an incremental but significant contribution to the literature on this burgeoning topic. In doing this, we seek to attend to children’s absence in placemaking and smart cities by proposing implications and strategies for addressing their exclusion.

Background work
Technology’s greater role in the management of public spaces poses significant implications for placemaking (Karvon et al., 2018; Tenney and Sieber, 2016). The companies responsible for these technologies claim that providing public servants with data leads to ‘better’ decision-
making, but scholars have argued smart cities pose privacy concerns and offer little value for ordinary citizens (DiSalvo and Jenkins, 2017; Krivy, 2016; van Zoonen, 2016). The overarching neoliberal logics that accompany smart cities pose urgent questions of who smart cities are for and who has a right to shape them (Heath et al., 2019). In response, calls for people-centred smart cities seek to involve those without a voice in city-making processes and create spaces for critical engagement with the visions and technologies driving smart cities (Hunter et al., 2018). This would help move us beyond ‘cookie-cutter’ approaches (Townsend, 2013) towards more inclusive and sustainable smart cities (Heitlinger et al., 2019).

The vision of smart cities involves integrating technical sensors into the urban fabric to gather precise data about the environment, infrastructure, and resources (Ratti and Claudel, 2016). These amplify the abilities of human senses, e.g. to ‘see’ air pollution invisible to the eye (DiSalvo and Jenkins, 2017). Scholars suggest community-led investigation, using portable and low-cost versions of these tools (Balestrini et al., 2017), could open new avenues of constructing knowledge in smart cities and involve a broader range of citizens in their realisation. However, to date, limited engagement has taken place with politically marginalised groups (Balestrini et al., 2017; Gabrys, 2016).

Children and the smart city

Despite increasing recognition of the important role of citizens in crafting smarter cities (McKinsey Global Institute, 2018; Wilson and Chakraborty, 2019), children are rarely involved in built environment projects supported by smart technologies. Understanding children’s relationships with public space, digitally augmented or otherwise, is fundamental to our holistic understanding of cities (Horschelmann and van Blerk, 2013). Yet only a handful of scholars have explored the role of children in the smart city at all (e.g. Nijholt, 2019; Scholten, 2017; Wolff et al., 2019), and no known work has provided opportunities for children to engage with smart technologies in public spaces.

In the last 15 years, digital methods such as computer simulation games have gained traction for youth engagement in city-making (de Andrade et al., 2020; Mallan et al., 2010). Previous work from two of the authors has involved children using bespoke digital tools to specifically involve children in placemaking (Peacock et al., 2018). This involved using open-source mapping software in combination with school activities to translate formal placemaking processes into meaningful and creative engagements with children. Here, adults and children working together in a community placemaking project provided new insights and opportunities for improving their neighbourhood; but it also opened new spaces of conflict as children’s views were ‘disruptive’ to the process (ibid, p. 8). This work reiterated the need to configure placemaking processes that legitimise children’s contributions and support their participation alongside adults (Freeman and Tranter, 2012). Building on this work, we set to involve children in a critical interrogation of smart city tools and the value of such tools for participatory placemaking.

Research context

Newcastle upon Tyne has recently launched its own smart city initiative, centred on deploying sensors to monitor waste disposal, traffic, parking, and air pollution, and pushing this data to a publicly accessible online dashboard (Urban Observatory, 2020). Meanwhile, air pollution is found to breach safe legal limits on some major roads in the city. In response, residents in a neighbourhood two miles from the city centre founded an action group to campaign for measures to reduce private car use (e.g. new segregated cycle routes.) Seeking ways to place children
at the centre of their efforts, this group asked for our help to gather evidence of air pollution with the involvement of local children. This led us to co-design a pilot engagement in collaboration with a local primary school. This school fronts a busy road close to the neighbourhood centre, and over half of its students live in walking distance. The headteacher also corroborated air quality, traffic, and noise pollution as issues affecting them. We worked with one class of Year 4s (third graders) across the three workshops, at the headteacher’s recommendation, and designed the workshops in collaboration with their class teacher to ensure it would be appropriate for students’ needs and abilities.

Designing our engagement

We structured activities around using handheld versions of environmental sensing tools to gather evidence and come up with placemaking ideas for their neighbourhood. For our pilot, 27 children took part in three consecutive workshops: a sensory exploration of their neighbourhood close to the school, achieved through a guided walk using handheld sensing tools, a voice recorder, and an iPad as tools for observation recording; thinking through the findings from their walk through creative activities (e.g. story-writing); and generating placemaking ideas to improve their neighbourhood and communicating these through posters, drawings, 3D models, and demonstrations. The children we worked with were 8–9 years old, and there was a close-to-even gender split. The class was demographically diverse and of mixed ability. At the teacher’s recommendation, children worked in pre-set teams of five to six throughout. We delivered our three workshops in normal school time – the first two lasting two hours each, and the third three hours with a break. Prior to running these, we sought full ethical approval for our data collection through our university’s ethics committee.

The three different sensing tools we obtained could monitor and display live readings of air quality, environmental sound levels, and the speed of oncoming traffic. We structured our engagement around questioning what they could ‘sense’ in their environment using the five senses – sight, hearing, smell, touch, and taste (Goodchild, 2011). Curious about the creative possibilities of what our participants might be able to sense with, and without, the tools, we structured the engagement as a comparison between the two. Using their human (embodied) senses, and using the (technical) sensing tools, how would our participants ‘make sense of’ the environment and how would this contribute to their evidence-gathering? What could they see, hear, smell, and feel through these two mediums?

Once the children had brought their ideas to life, we invited four representatives from the city council to join with the children in an ‘Ideas Carousel.’ This was an opportunity for the children to exhibit their evidence and ideas to give peer-to-peer feedback (i.e. what did you like most about this group’s idea?), discuss the implications for the wider community (i.e. what would need to happen locally to make it a reality?), and influence city decision-making with the city officials present. Throughout this activity, the class teacher emphasised students (and the visitors) giving positive and constructive feedback, as opposed to critique.

Insights on a pilot engagement

Our insights centre on three observations from our engagement. First, how the contrasting of embodied and technical sensing generated issues of trust in relation to data production. Second, the exploration of playful possibilities for sensing their environment. Third, the ways in which the tools supported the generation of ideas and responses to local issues.
Contrasting embodied and technical sensing

Our first observation was that the children approached their exploration with a degree of caution, comparing both their observations and the readings from the monitors before reaching any conclusions. But our walking activity surfaced interesting tensions between whether to place more trust in the sensor readings, or their own embodied feelings. For example, the air quality monitor reported higher levels of pollution the further they stood from the busy ‘front road’:

I think [here] has more pollution in than the front road, but it’s pretty hard to tell why.
Because […] the front road, had lots and lots of cars, but there’s hardly any cars here.

[voice recording, workshop 1]

However, just because the sensors told them it was not polluted or noisy, they did not reject their initial observations out of hand. Here, in the absence of the sensors providing clarity, it was the contextual readings of their neighbourhood – knowing the issues of traffic outside their school – that instead helped them to reach these conclusions. This encourages us to think through the respective roles of our embodied senses and of digital technologies: just as there are limits in what we can see and hear, there are limits to how sensors can generate useful information about our neighbourhood.

While these tensions surprised us, they also transpired as an opportunity and a resource for the children; not only to think critically about smart city tools, but also more generally about the trustworthiness of environmental data. Children reminding themselves to trust their own judgements (as opposed to those made by the sensor tools) showed the potential for the tools and the results they generate to serve as a resource for critical comparison between human and machine-generated data. Rather than the latter just serving to validate the former, the latter actually strengthened the former and convinced the children that the assessments they made using their own senses were more likely to be accurate, encouraging us to question what it means to engage children in using these kinds of sensing technologies.

Exploring possibilities in their environment with the sensors

Our second observation was that the children’s use of the sensors revealed the intrinsic potential that such tools hold for fun, open-ended, and creative interpretation of their possible uses. For example, participants tried recording the speed of other things in their environment and shouting into the sound-level meter to see if it would report a higher decibel level. Their motivation for doing so appeared to relate to a desire to play and experiment (as children do) with the sensors, as opposed to obtaining accurate readings.

Throughout the walk, we were reminded of the obscurity of environmental sensing tools – within and beyond our engagement – by the limited ways that the children could interact with them. Only the traffic speed monitor allowed for two-way interactions through its red button to take a reading, while the other monitors simply allowed for passive observation of numbers and graphs. It was also unclear how the monitors calculated these numbers (i.e. how the algorithms behind them worked.) We were encouraged by one of the participants using this ambiguity as a resource (Gaver et al., 2003) to imagine what the inner-workings of the air quality monitor looked like. Questioning how an air quality monitor decides how good or bad the air is, they wrote a reflective story to personify what might happen to an air pollution particle being scanned by the monitor:

I am a small micro-meter sized dirt particle […] I was following [the team] around their air investigation, but as they were seeing how bad a bus was, I was sucked into
a green machine brown as a frog […] I was scanned all over and it TICKLED soooo much. The frog gave me a big SHOVE! And I was back in the air.

[reflective story, workshop 2]

Imagining air-quality sensing as a playful interaction between the environment and the tools (being ‘tickled’ and ‘sucked in’) exemplified the potential to engage in fun activities with children while making sense of serious issues — the opaque, ‘black box’ configuration of technologies used in smart cities.

**Generating place-based ideas and responses to issues**

Our third observation was seeing the tools used by the children to gather evidence about serious issues in the environment. One of the most pressing issues among the groups was litter, which they conflated with air pollution as causing a blight on their neighbourhood and a priority for the whole community to tackle. One child took issue with various discarded items on a bench outside their school gates:

You can see this purple rag, and then there’s a blue towel, and a soft toy… this is hopeless, and it is not representative [of the community]! We can do better.

[voice recording, workshop 1]

Using this evidence, they responded with creative ideas that would remediate this issue and others to transform their neighbourhood. The ideas they came up with were: The Travelator, a moving walkway to replace all roads in the neighbourhood; Duodecacycle, a solar-powered ‘pool bike’ carrying 12 people to different destinations; Bin Bus, with a 2-minute frequency for passers-by to dispose litter easily; International Robot Bins, a colourful solar-powered bin with vacuum-cleaner hands, detectors and drones; and Moving Bin, a similar idea that comes with an integrated ‘pooper scooper.’

These ideas embody the playful approaches we saw earlier, but they still deal with serious issues grounded in the evidence they had collected about air pollution, traffic, and litter. They constitute meaningful reimagining’s of the civic realm and how citizens might go about their lives differently, which if put into practice would contribute new street furniture (mobile bins), alternative modes of shared, sustainable transport (Duodecacycle) or more comprehensive rethinking of how we travel (Travelator). Their placemaking ideas may seem distant from reality; but we could see them as creative amalgamations of several existing technologies. Moreover, all of these spoke to the value of technology solving ‘wicked’ problems of litter, pollution, and traffic in the absence of care and attention given by the wider community, or the city council.

Thus, using the sensing tools seems to have encouraged them to think about how other technologies could be used to improve their neighbourhood as part of a wider placemaking initiative. Such radical ideas for reforming waste management and polluting travel behaviours would not feel out of place in a smart city vision either. One of the city officials who saw the children’s ideas confirmed this:

I really like the fact that everyone’s started to think about robots and how technology can help […] I think we’re still looking at robots as what we think of in cartoons, but I think there is a space for using the technology behind that to think of having some of that in bins.

[voice recording, workshop 3]
Their ideas to take action and make a positive change reiterated the value of our engagement, in that the sensing tools had their limitations, and were subject to significant critique, but they still proved useful for the gathering of evidence to remediate important issues in their neighbourhood. It also hinted at what could be possible if children and city officials were to collaborate in more productive ways – a fruitful direction for future research.

### Designing approaches to support children’s inclusion

Our engagement and activities supported children as young as eight to question the legitimacy of data, and whether it can ever be regarded as an exhaustive or objective measure of truth (Gabrys, 2016; Gitelman, 2013). The activities offered children an opportunity to compare and contrast situated technical sensing against their embodied senses observed at the same time and location, thus supporting them to explore the spatial, temporal, and social dimensions of data bound up with the material specificities in which they were gathered – what Taylor et al. (2015) term ‘data-in-place.’ Our case points to the promising potential for processes that support children developing critical skills to question algorithms bound up in smart cities too (Wolff et al., 2019) – e.g. making sense of the air quality monitor’s ‘black box’ through story-writing. This is all the more critical when such algorithms play an increasingly significant role in the configuration and management of public space (Tenney and Sieber, 2016).

The ambivalences surrounding the sensor data transpired as valuable for introducing children to the processes and technologies involved in smart cities and opening a space for them to contribute their own ideas. But we also recognise the limitations of our pilot, and the need for institutional processes to change to accommodate children’s voices if their ideas are to result in transformative action (Hautea et al., 2017; Jenkins et al., 2016). In our engagement, the dialogue with the city officials showed in some ways that data as evidence is still powerful to advocate for changes in the city. But while they warmed to the children’s ideas, our engagement sits alongside the growing body of evidence that emphasises the political pressure and structural changes required for parity in children’s contributions to city-making processes – in other words, commitments from decision-makers to act on their evidence and implement their proposals (Jenkins et al., 2016; Nordstrom and Wales, 2019; Peacock et al., 2018).

Drawing on our insights, we propose three concrete ways that placemaking scholars and practitioners might build on our work to develop socio-technical processes to include children in making people-centred smart cities.

### Give prominence to context and subjectivities in smart cities

Context played an important role in the children’s data gathering. For these children, it was not necessarily about collecting the quantitative data they needed – it was about obtaining a deeper understanding of their neighbourhood to decide how to improve it. Our methods gave them scope to draw on their own, contextual knowledge, e.g. expressing concerns about pollution from cars despite the confusing air-pollution readings. In our engagement, they collected experiential data that they could not have obtained using the city’s data dashboard and put this to use in their ideas. But despite its apparent value in our engagement, this kind of subjective, citizen-generated data is rarely favoured over ‘objective’ numerical data in the smart city (Townsend, 2013). Scholars and practitioners might wish to give prominence and value to these subjectivities. This would help to reframe smart cities on the capabilities of the citizen and their respective contributions to realising smarter cities, especially from politically marginalised groups like children (Balestrini et al., 2014). Placemaking practitioners could draw inspiration from critical
Exposing the limitations and seams of smart technologies

Another way of facilitating critical reflection on the design of smart cities might be the deliberate exposing of gaps and limitations of smart technologies. We witnessed the children experiment and test the limits of what they could sense, such as the noise-level of shouting – exposing what Human–Computer Interaction scholars call the ‘seams’ of possible interactions with the tools (Chalmers et al., 2004; Sengers and Gaver, 2006). Deliberately exposing these ‘seams,’ as opposed to concealing them, can draw attention to the limits of technologies and open spaces for new possibilities for their use. In civic contexts, Korn and Voida (2015) argue this can expose power relations embedded in technologies to create a space for citizens to subvert, manipulate, and imagine alternative possibilities for cities. Our deliberate contrasting of sensors and embodied feelings communicated to the children that technology is fallible and should not be taken at face value. Future work could experiment with embracing the gaps, in order to promote critical thinking around how people and technologies could work together to shape places and what the value might be of each for crafting smarter cities (Balestrini et al., 2017; DiSalvo and Jenkins, 2017).

Open playful spaces for designing cities and technologies

Running through our engagement was a desire for ludic interactions with the tools and their environment. We kept possibilities for using the tools open to create a design space where children could have fun in the process (Dix, 2003). Civic designers highlight the importance of scaffolding collaborative, creative, and open-ended engagements for children that allow for self-expression and use of their imagination (Wood et al., 2014). Our walking, storytelling, and idea-generation activities respectively ‘pushed the envelope’ and opened possibilities for creative responses in the context of placemaking. Such creative methods have a significant tradition in the social sciences (Bates and Rhys-Taylor, 2017; Brooks et al., 2020); here we adapted these to encourage critical interaction not only with the politics of placemaking and city planning as explored previously (Crivellaro et al., 2015), but also with the politics of data-collection processes and technical sensing. These methods resonate particularly with young children, whose natural curiosity, creativity, and enthusiasm can serve as an ‘untapped’ resource for the transformation of the built environment (Peacock et al., 2018).

The contrasting of experiential and technical evidence also had the effect of introducing them to complex debates around the reliability of data and algorithms behind smart technologies (i.e. how did the machine arrive at that number?) Here, we build on the work of other scholars who have attempted to do this through dialogical (Heath et al., 2019) and kinaesthetic (Andersen and Wakkary, 2019) methods, such as exploratory making and discussions, and demonstrate the value of doing this with children. However, we saw children struggle when they could not see how the technical sensors arrived at their readings. We suggest that future work should meet children closer to where they are at in their lives by being playful, interactive, and drawing on their lived experiences as learners (Lui et al., 2014) and as citizens (Cockburn, 2013;
Wood et al., 2019). Such design activities could involve opening up ‘black boxes’ of smart city technologies (DiSalvo and Jenkins, 2017), making smart city data tangible (Nissen and Bowers, 2015) or appropriating technologies to help them address placemaking issues in their neighbourhood (Jenkins et al., 2016).

Conclusions

If smart technologies are increasingly implicated in the making of future cities, important questions remain as to how we can prepare children for such a future. Through the comparisons of sensory and technical data, our insights suggest our activities effectively facilitated critical evidence-gathering and analysis among children. Aside from some light-touch scaffolding to frame the engagement, children worked to gather evidence and mobilise this to produce ideas for the future of their neighbourhood. This gave us a window into the possibilities for children to have greater agency in smart cities and smart technology design. While our pilot study is a modest initial experiment, it shows that there is significant value in engaging children with smart city technologies as a way to both generate ideas for changes in the places where they live and to develop critical thinking in relation to data and sensor technologies. However, while understanding the workings and limitations of smart technologies is a start, harnessing the potential of technologies to advocate for changes they want to see is an altogether bigger challenge. It is clear that we have a long way to go before children are recognised as competent actors in placemaking processes (Freeman and Tranter, 2012). For city planners and designers to involve children in the making of inclusive, sustainable, and people-centred smart cities, we must create the conditions to enable children to exercise their right as citizens to help shape the cities and technologies of the future. The recent youth climate strikes show the potential for addressing this challenge, as children across the world mobilise compelling data around the climate emergency to influence environmental policy (Singh et al., 2019). We hope that the insights and ideas we offer here will help placemaking scholars and practitioners to address the challenges of children’s participation in making people-centred smart cities.

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References


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