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Change – The transformative power of citizen science

Citizen science on bikes in museums and schools: being part of mobility change research with the senseBox:bike

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Abstract

Bikes and bike friendly cities are becoming the core theme of mobility change. In the presented projects we apply and investigate data-driven and participatory approaches to enable changes in bike-friedly policy and city infrastructure. Together with Futurium - house of futures - and several fablabs we co-designed a participatory approach to empower citizens to be part of the mobility change in Berlin. 30 citizens participated in the senseBox:bike workshop, built mobile senseBoxes to measure environmental phenomena, distance of surpassing cars and road or bike-lane quality. Some of the citizens collected mobile data for over 2 years, which was published as open data on openSenseMap and visualized in an interactive “living exhibit” in the Futurium Lab. We organized an intermediate lab meeting with some of the participants to discuss feedback, usability and the software of the protoypical device and re-co-designed the senseBox:bike to an open source product for mobile bike data collection. After two years we are meeting the citizen scientists again at Futurium and interview them about motivations, obstacles, experiences in the project. We adapted the approach with an more educational focus and designed workshops for five schools in Essen, evolving the participatory approach: the students work in the local quarters of the city, they build, program and mount the devices to their bikes, they conduct data collection and analysis, and then get into dialogue with local politicians, following the spatial citizenship approach.

Keywords: citizen science, mobility change, sensors, environmental monitoring.

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senseBox – a citizen science toolkit for everyone

A microcontroller, environmental sensors, a (graphical) programming interface, and open educational resources – that's all it takes to conduct IoT (Internet of Things) projects around environmental and climate protection with learners and interested citizens. This is demonstrated by a kit that combines these components in conjunction with citizen science: the senseBox. The data collected with the individually configured smart measuring device can be published and shared on the openSenseMap, an open environmental data platform. Thus, the DIY kit suits educational institutions and citizen scientists. Furthermore, a new variant – the senseBox:bike – can advance the transformation of data-driven mobility change.

senseBox:bike – Participation in mobility change

Bikes and bike-friendly cities are becoming the core theme of mobility change. In two pilot projects focusing on citizens in a museum (Futurium in Berlin) and schools (in Essen), we apply data-driven and participatory approaches to enable changes in bike-friendly policies and urban infrastructure. With the senseBox:bike cyclists collect data about the bicycle infrastructure while riding. This data on vibration, speed, and proximity to other road users can ultimately provide information about potholes and potential danger spots in traffic, among other environmental phenomena as temperature and air quality.

Berlin: Co-Designing the senseBox:bike with citizens

Research has shown that involving citizens in urban development processes can increase credibility, trust, and commitment to implementing such policies (Empel 2008). On their bike rides through the city, cyclists face various health risks (Apparicio et. al. 2016). Among others, air pollution may have severe effects on health and should have implications for urban planning. Nevertheless, particulate matter measurements are rarely carried out on a mobile basis at the position of cyclists but rather at a stationary position at the side of the road.

Another option for mobile data collection on the bike is the openBikeSensor. It offers a semi-automated solution for recording violations of the minimum takeover proximity. OpenBikeSensor uses an ultrasonic proximity sensor to measure the proximity to passing cars when the cyclist presses a button (e.g. in Hauenstein et al. 2023). However, it can be challenging to trigger the device reliably in hazardous traffic situations, which may result in stress and data loss.

Taking these challenges into account, together with Futurium and several Fab Labs we co-designed a participatory approach to empower citizens to be part of the mobility change in Berlin resulting in the prototype of the senseBox:bike.

30 citizens ("recruited" through social media channels of Futurium and senseBox) participated voluntarily in the senseBox:bike workshop at Futurium (Fig. 1), where they assembled, connected, and pro-

grammed the senseBox:bike, so each participant had their own device capable of collecting continuous mobile data on:

- proximity of surpassing road users
- road or bike-lane quality (measuring vibrations & bumps)
- Temperature and relative Humidity
- Fine Dust ($PM_{2,5}$ und PM_{10})
- Speed

The gathered data was published as open data on openSenseMap.org and visualized in an interactive "living exhibit" in the Futurium Lab. The participants were free to use the senseBox:bike for as long as they wanted, resulting in three types of participation of approximately same size:

- users, that only participated in the workshop and never used the senseBox:bike again
- users, that used the senseBox:bike on an irregular basis and only for up to 6 months after the workshop
- regular users still (more than two years after the workshop) using the senseBox:bike while commuting and in leisure time

Figure 1. Impressions from the senseBox:bike Citizen Science Workshop at Futurium. Credits: berlin-event-foto.de

After a year of use, we organized an intermediate lab meeting at Futuiurm. We invited all participants to share feedback on the usability and experience with the prototype. Only a few regular users appeared, bringing valuable feedback: from usability issues in the assembly process to ideas for hardware improvements and even contributions to the open-source code concerning location privacy issues.

Finally, after two years we conducted qualitative interviews with each one of the three different participant types about motivations, obstacles, and experiences for the project.

On the one hand, the regular user was motivated to actively contribute to its improvement. The other users stated that the process of attaching the box to the bike was too troublesome and that the box's own weight of half a kilo contributed to it not being used as often as intended. They added that they did not fully understand the process of acquiring and uploading data, which is why the box was not used or used less frequently.

The limitation of the first prototype in daily use was clearly its ease of use. The results underline the importance of accessibility and understandability of technology-driven citizen science projects. With the experience and feedback from the Futurium, we adapted the approaches of workshop and hardware to reach a different group of citizens: young people.

City of Essen: Young people engage in urban development processes

Young people often exhibit creative thinking and unconventional problem-solving approaches, showcasing the potential to disrupt traditional thought patterns. This attribute proves particularly advantageous in the context of urban planning, which is known for its complexity and time-consuming nature. Participation in urban planning is deemed a prerequisite, fostering communicative dialogues between local stakeholders and experts. However, participation processes frequently exclude young generations (Kogler 2018). At the same time, approaches to the involvement of young people receive a significant amount of public attention (Bruselius-Jensen et al. 2021).The project "Essen auf Rädern - Young People Develop Concepts for Cycling in the Ruhr Metropolis using Digital Geomedia" (funded by the German Federal Foundation for the Environment, DBU) addresses this issue.

Thematically, the project aligns urban planning with the ongoing mobility transition, particularly cycling. Essen, as highlighted in the ADFC city ranking of 2022, currently lags behind in sustainability-oriented mobility transition among cities with over 500,000 inhabitants. Consequently, significant changes are imperative for the city (ADFC 2022).

Technology-wise the project builds up on the Futurium experience by improving the usability of the hardware and software of the senseBox:bike and making the assembly, mounting and data collection process much simpler and safer (Fig. 2).

Methodologically, the project adopts the spatial citizenship approach, which outlines the skills and willingness of young people to actively engage in spatial decision-making in society through the competent and reflective use of technology (Gryl and Jekel 2012). Taking this guiding principle into account, project weeks at five secondary schools in Essen were designed and implemented. Specifically, the

Figure 2. Collecting data with the senseBox:bike

students a) collect spatial data on cycling infrastructure and environmental phenomena in their respective school districts with the senseBox:bike, b) analyze this data from their unique perspectives, c) present their findings to the public and politicians, and d) actively engage in societal discourse. Collaborating with stakeholders from academia and local initiatives, the data and the measures derived from it are processed (in data visualizations, maps) for the public and local politicians. This database, emphasizing data-driven objectification and evidence, provides a tangible voice to young participants in the discourse.

Conclusion and future work

The two examples provided have exemplified great interest and opportunities, but also challenges in expanding bicycle infrastructure based on data, in collaboration with citizens of different ages. Therefore, the projects are being transferred to additional cities - both within Germany and internationally. The BMBF-funded project "atrAI bikes" involves citizens from Münster and Sao Paulo working with a improved senseBox:bike, where AI-approaches will lead to better data quality and data analysis within a distinct bike-data-platform.

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