Advancing critical data literacies through citizen science

Dr Javiera Atenas, PHEA

Senior Lecturer in Learning and Teaching Enhancement, **School of Business, Arts, Social Sciences and Technology** j.atenas@uos.ac.uk

University of Suffolk

Key concepts

- Data literacy is normally understood as a set of the ability to read, understand, create and communicate data as information. Like literacy as a general concept, data literacy focuses on the skills involved in working with data. Data literacy can be also understood a mean to participate in the (datafied) society, thus the skills needed to work with data go beyond technicalities and have a strong social component.

- Data literacy has been defined by for Prado and Marzal (2013), as the skillset that "enables individuals to access, interpret, critically assess, manage, handle and ethically use data" (p. 126)

Key concepts

- Critical data literacy has been defined by Brand and Sander (2020) as "the ability to critically engage with datafication by reflecting on the societal implications of data processing and implementing this understanding in practice" (p. 2). Critical data literacy that acknowledges the circumstances of oppression in the current pervasive datafication of human beings and society (Atenas, Havemann and Timmermann, 2023).

- Citizen science is an engagement method that actively involves citizens in various stages of the scientific research process. Citizens may contribute to problem definition, quality assurance, data collection and analysis, and interpretation. This citizen-collaborative approach provides local involvement and the opportunity to expand the knowledge base, making research more accessible and inclusive

Approaches to citizen science

Citizen Science

- is the voluntary participation of nonprofessional scientists in research and innovation at different stages of the process" (Citizen Science Factsheet, 2020)

Civic Monitoring

- is a form of active citizenship in which groups of people or individual citizens share methods, tools and carry out activities to control, verify, collect ideas on public policies and on how public money is spent.

A Spectrum of Public Participation

Low — High

Inform | Consult | Involve | Collaborate | Empower
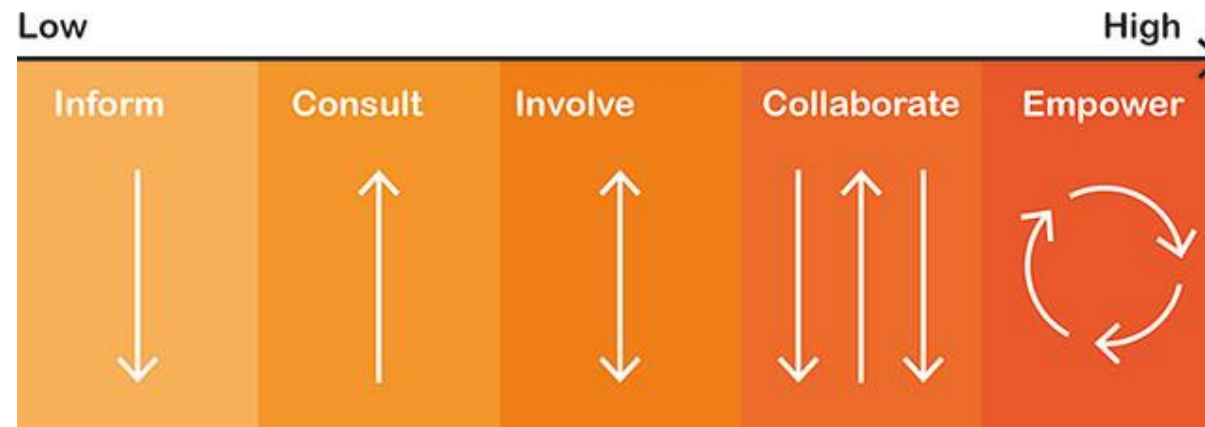
Volunteer Thinking

Data led activities can help closing the gap in of digital inequity

- Crowdsourcing can support dataset preparation and classification, even alongside machine learning.
  - Library-supported citizen science projects can leverage community contributions.
- Citizen science projects must balance scientific goals, scale and depth of engagement, and benefits to stakeholders.
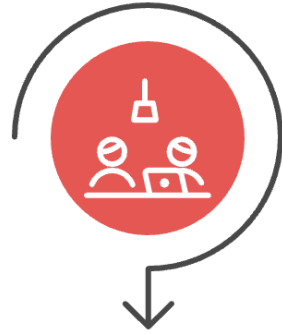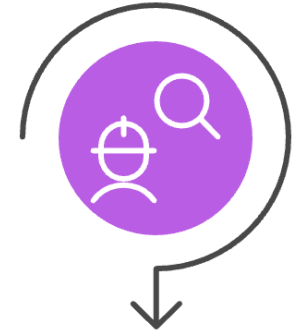 - Stakeholders include scientists, participants, and funders.

Contractual **Contributory** **Collaborative** **Co-Created** **Collegial**

The 5 Cs of Citizen Science

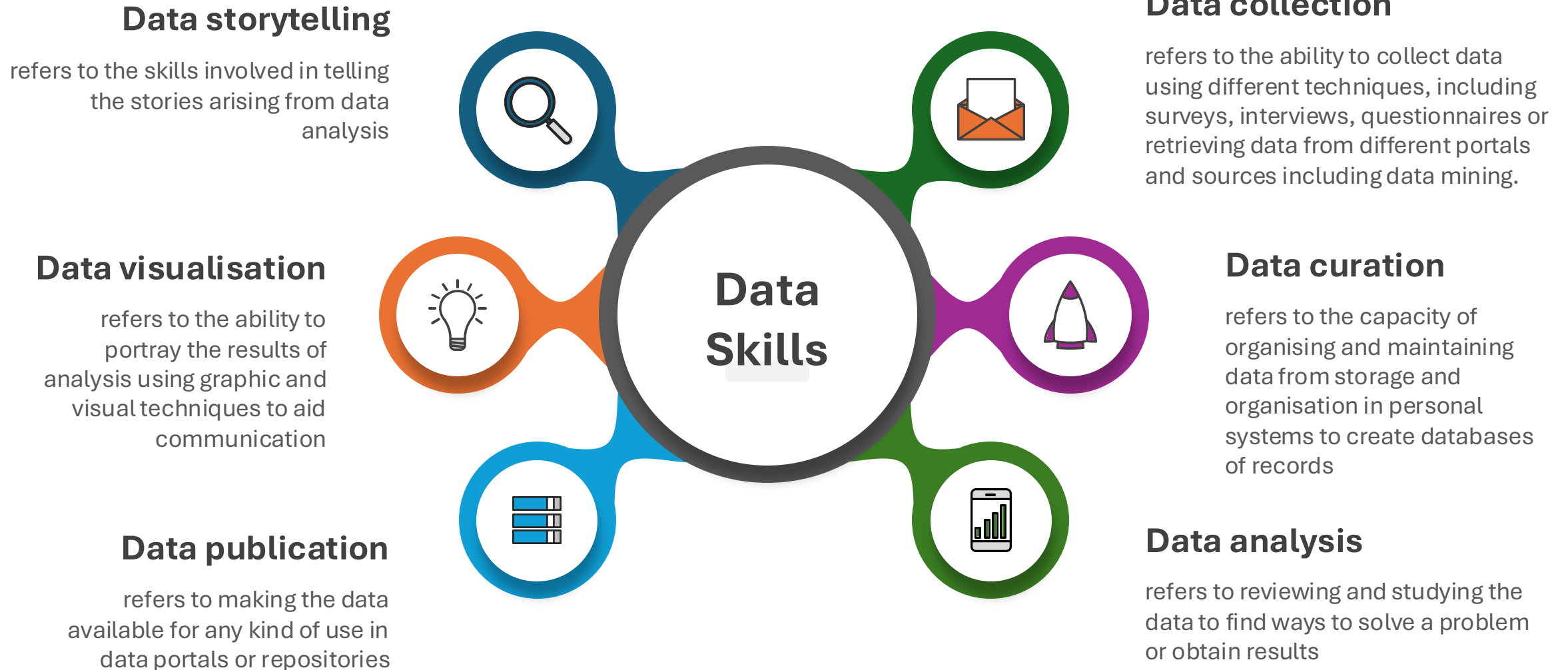Contractual: Communities request research by professionals.

Contributory: Designed by scientists; public contributes data.

Collaborative: Public contributes data, design, analysis, dissemination.

Co-Created: Public and scientists co-design and co-implement.

Collegial: Non-credentialed individuals conduct independent research.

Basic data skills

Data storytelling

refers to the skills involved in telling the stories arising from data analysis

Data collection

refers to the ability to collect data using different techniques, including surveys, interviews, questionnaires or retrieving data from different portals and sources including data mining.

Data visualisation

refers to the ability to portray the results of analysis using graphic and visual techniques to aid communication

Data Skills

Data curation

refers to the capacity of organising and maintaining data from storage and organisation in personal systems to create databases of records

Data publication

refers to making the data available for any kind of use in data portals or repositories

Data analysis

refers to reviewing and studying the data to find ways to solve a problem or obtain results

Dr Javiera Atenas, University of Suffolk

Libraries and Citizen Science

- Libraries play a crucial role in enabling citizen science through infrastructure, training, and partnerships: Libraries help build capacity, foster scientific literacy, and support community engagement.

- Capacity development is often the missing link in citizen science initiatives: Training, infrastructure, and organizational support are key to success.

- Project planning and scientific literacy frameworks support participants in engaging effectively: Libraries could co-create structured guides to scaffold citizen participation.

Millett, A. C., Burrows, K., Caldwell, N., & Richards, S. (2025). Suffolk Libraries: enhancing well-being within its community. *The Journal of Positive Psychology*, *20*(6), 1049–1059. https://doi.org/10.1080/17439760.2025.2502484

Citizen science approaches

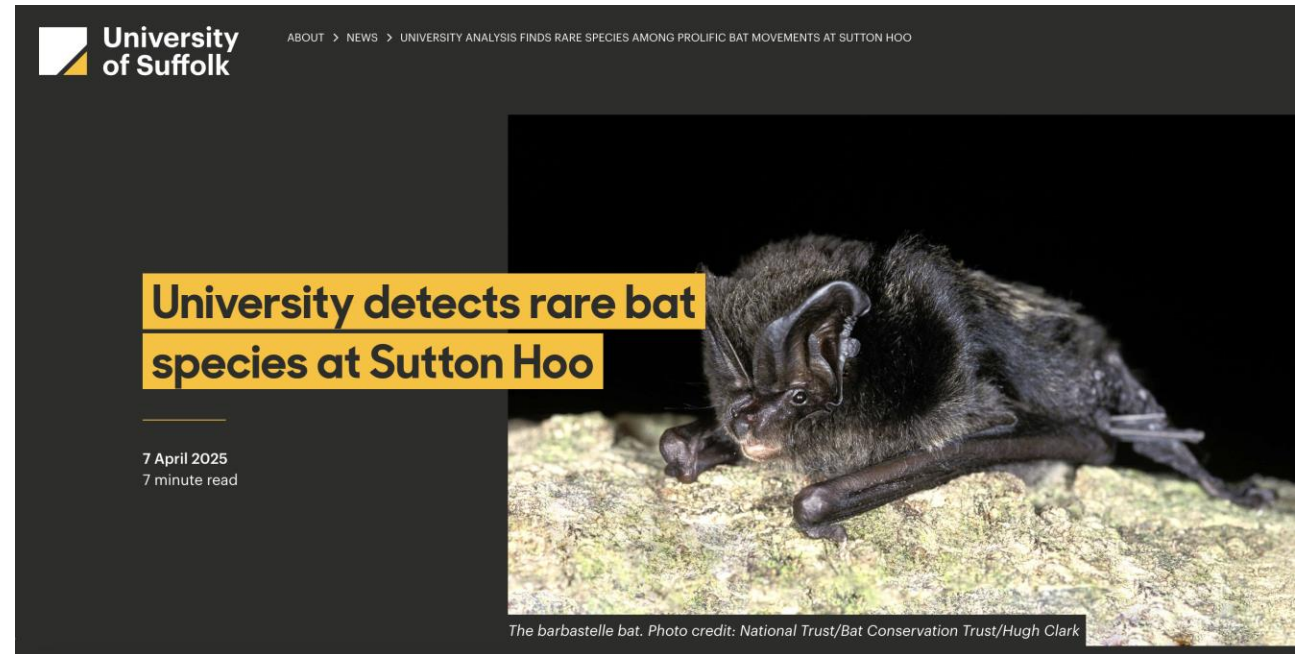| Group	Using Records / Observations	Producing & Creating Open Data	Using Data	Driving Insights & Reports
Children	Guided observation tasks; simplified recording sheets; gamified data entry.	Child-friendly apps; visual upload tools; adult support for verification.	Simple dashboards; storytelling with charts.	Collaborative storytelling; drawing-based or audio reports.
Teenagers	Mobile-based observation tools; social media–integrated data logging.	Use of smartphones, sensors, AR/VR tools for richer data capture.	Basic data analysis workshops (e.g., spreadsheets, Scratch, beginner Python).	Multimedia reports (videos, infographics, blogs); peer-driven communication.
Adults	Standard fieldwork or digital logging; community-led observation events.	Contributing photos, audio, environmental readings, surveys.	Intermediate data literacy activities; community data-cleaning events.	Writing community reports; participating in interpretation meetings.
Senior Citizens	Memory-friendly forms; analogue options (paper logs) with digital support.	"Assisted digitisation" sessions; voice-to-text tools; large-font apps.	Guided data exploration sessions; simplified visualisations.	Oral-history–based interpretations; co-presenting findings with teams.
People with Disabilities	Accessible forms (screen-reader compatible, alt-text, high contrast); sensory-adapted activities.	Inclusive data capture: voice commands, tactile sensors, easy-grip devices, captions.	Accessible dashboards; multimodal learning (audio, tactile, visual alternatives).	Easy-read summaries; audio/video storytelling; collaborative interpretation circles.
Communities (mixed groups)	Community walks or events that combine diverse needs.	Shared datasets using open standards; community-curated data validation.	Workshops on understanding local data for action.	Co-creation of community reports, exhibitions, podcasts, or local advocacy materials.

Data skills

Skills / Level students can	Basic	Intermediate	Proficient	Advanced
Critical thinking	Understand basic concepts of critical thinking	Use data to verify information from the media	Analyse phenomena from their region using data and write reports critically analysing solutions	Present data visualisations to present their findinds using complex statistical modelling
Data analysis skills	Analyse data using quantitative and qualitative methods	Use proficiently software for data analysis such as SPSS - NVivo	Use proficiently software for data analysis such which are relevant for their own discipline	Develop their own databases using systems such as ORACLE
Data curation skills	Organise datasets in simple folders	Identify different sources of datasets and organise it in databases	Use digital tools for data curation and share it with others	Develop databases and organise datasets, and embed metadata into the files to facilitate access to the resources
Data management skills	Identify datasets from different sources	Select datasets from different portals in different formats	Extract, filter and compare data from different data sources creating a single dataset	Filter and format data in different formats analyse it creating complex datasets

Data skills

Skills / Level students can	Basic	Intermediate	Proficient	Advanced
Data Mining skills	Locate CSV files on the internet	Extract datasets from PDFs	Extract datasets from different sources	Use complex methods for developing datasets
Data visualisation skills	Create graphics and charts	Use online software to develop simple infographics	Use graphic design software to develop infographics	Use data modelling software to create complex data visualisations
Research skills	Understand the scientific method and are familiar with basic quantitative and qualitative methods	Structure their research and apply different techniques to obtain results	Replicate experiments and studies following research methods explained in the literature	Compare data and information from different data sources and research papers and replicate experiments and studies to produce new research articles
Statistical skills	Perform basic statistical operation including averages, media and median	Perform statistical operations using clusters, using standard deviations, signifiance, chi square, correlation or regression analysis	Use data modelling techniques for different statistical methods such as forecasting to predict future events	Programme databases to perform complex statistical analysis and create models and complex graphs and visualisations

Our experience

A citizen science partnership in Woodbridge which has expanded to cover Sutton Hoo has reported a thriving bat population at the National Trust site – including detections of one of the UK's rarest bat species.

The barbastelle bat. Photo credit: National Trust/Bat Conservation Trust/Hugh Clark

https://www.uos.ac.uk/about/news/university-analysis-finds-rare-species-among-prolific-bat-movements-at-sutton-hoo/

References

Adewumi, B., Onwuka, E. C., & Idowu, D. O. (2021). *The missing link: The capacity development for... Library Management, 44*(6–7), 437–452. https://www.emerald.com/lm/article/44/6-7/437/262036/The-missing-link-the-capacity-development-for *(Note: complete author list & page numbers taken from Emerald URL metadata; adjust if you have full citation details)*

Alving, B. E. (2021). *Increasing scientific literacy with citizen science* (Citizen Science Skilling for Library Staff, Researchers, and the Public). LIBER Citizen Science Working Group. https://cs4rl.github.io/skills/#/files/cs1013increasing-scientific-literacy-with-citizen-science

Cigarini, A., Bonhoure, I., Vicens, J., & Perelló, J. (2021). *Public libraries embrace citizen science: Strengths and challenges. Library & Information Science Research, 43*(2), Article 101090. https://doi.org/10.1016/j.lisr.2021.101090 ScienceDirect

Jenkins, S. (2024, November 8). *Driving citizen science success through academic libraries*. Elsevier. https://www.elsevier.com/connect/driving-citizen-science-success-through-academic-libraries www.elsevier.com

Laursen, L., & Kaarsted, T. (2021). *Project planning: A step-by-step guide* (Citizen Science Skilling for Library Staff, Researchers, and the Public). LIBER Citizen Science Working Group. https://cs4rl.github.io/skills/#/files/cs1003project-planning-a-stepbystep-guide GitHub

Millett, A. C., Burrows, K., Caldwell, N., & Richards, S. (2025). Suffolk Libraries: enhancing well-being within its community. *The Journal of Positive Psychology*, *20*(6), 1049–1059. https://doi.org/10.1080/17439760.2025.2502484

Dr Javiera Atenas, PHEA

School of Business, Arts, Social Sciences and Technology

University of Suffolk j.atenas@uos.ac.uk