The potential of citizens science for socio-spatial studies. Defining and operationalising research pathways

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Abstract *- The term Citizen Science has been used in various contexts, but little effort has been made to provide a vision of it in regard to socio-spatial studies, which are in the core of the research group* ***on Citizen Science in understanding and transforming the territory (CIDATE)****. The authors in this chapter represent widely diverse disciplines, including environmental engineering, economy, urban planning and design, landscape architecture and education. It intends to deliver a tailored and timely vision of how, with the help of Citizens Science, the democratisation of science can be promoted and, with this, a more collective and sustainable decision-making. This chapter is a result of a reflective dialogue between researchers, their projects and experiences tackling spatial and human development from different perspectives. It gathers the conclusions emerged in the organised debates and from the research projects carried out by the researchers, towards creating a broad understanding on the key issues that could help operationalise Citizen Science in future research efforts.*

Keywords *– Citizen science, socio-spatial research, literature review,*

INTRODUCTION

The term Citizen Science (CS) has been used in various contexts, but little effort has been made to provide a clear definition of it in regard to socio-spatial studies. As different perspectives may lead to different results, tailoring the concept and providing guidance is essential to obtain the best possible from future actions. In order to do so, the Working Group on Citizen Science of CIDATE-CeiED, set a number of tasks, including:

- the search for relevant pieces of literature and their systematic review,
- taking notes for a qualitative and integrative/interpretive forms of review of the various research projects already carried out at the CIDATE, and

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- positioning ourselves on important issues related to CS along with developing key recommendations on how CS could best be operationalised in the context of socio-spatial studies.

Citizen Science (CS) emerged as a field of research and practice in the 1990s, and refers to the active engagement of the general public in scientific research tasks. It emerged from a variety of participatory approaches (action research, systems thinking and practice workshops, surveys and questionnaires, participatory GIS, etc.) that had already been developed, illustrating a strong need to not only democratise decision-making processes and involving people in projects but also to improve the quality of data gathered when making policies that lead to societal changes (Vohland et al., 2021). Originally conceived to facilitate good-quality large-scale data gathering, CS has the potential to transform the way in which we envisage scientific research and its impacts, who provides data as part of scientific research could also have a say concerning the scientific approach and the benefits research should bring. The collective creation of knowledge, through discussions between experts and practitioners, is questioning roles and giving a voice to those who, despite generally being viewed as the 'passive public', often knows best. Traditionally used in natural sciences, CS is now extending its range of activities to social sciences and gaining popularity (Crain, Cooper & Dickinson, 2014). Research in all disciplines could benefit from it and contribute to its advancements – the question is how.

A socio-spatial study, as understood here, encompasses broad research with focuses on the production of the space (urban, rural, natural, regional or land-wide), the relational connections with the community who produces and consumes such space and the technical, political and governing principles that rule the use of the space (Taylor, 1998; Smaniotto, 2019). Such location-based network is the methodological and theoretical key of urban planning, and subject to experimentation, analysis and systematizations of research. It also encompasses the different categories in the efforts to "understand and organise" the spaces and society and the forces that govern both (Taylor, 1998). A socio-spatial study describes thus the amalgamation of different areas of knowledge converged to the territory, through interdisciplinarity and transdisciplinarity perspectives.

As Heigl et al. (2019:1) stressed, "*CS has amazing potential as an innovative approach to data gathering and experimental design, as well as an educational and outreach tool. Let's make sure that future CS projects have sufficient rigor to earn the respect of participants, scientists, and policymakers*". The beginning of networks of professionals in different countries, such as the USA, Australia, and in Europe with the European CS Association, and the funding agencies (e.g. the European Horizon 2020 "Science with and for Society" in 2017) promoting CS, have started in placing the focus on the participants' side (the "citizens"). Therefore, it is essential to draw attention to legal and ethical issues such as intellectual property, privacy, scientific integrity and rigour. Neither definitions nor methods of CS are harmonised yet. Societal needs, communities, scientific interests and approaches evolve rapidly. Working on socio-spatial studies particularly helps in highlighting 'changing contexts' in both places, people and placemaking. It is from these perspectives that we are seeking a better understanding of an evolving way of pursuing research.

This chapter is a result of intensive debates organised in the scope of the working group on understanding CS for socio-spatial studies, which are the core of the

research group **Citizen Science in understanding and transforming the territory (CIDATE).** The authors represent widely diverse disciplines, including environmental engineering, economy, urban planning and design, landscape architecture, education and sociology, working together in creating knowledge on the sustainable use of natural resources and thus, inform decision-making. CS in spatial planning is relatively a new area of research. For this reason, it is relevant to reflect on how it differs from other participatory approaches, how innovative, and how the research activities, related to urban and territorial planning, can, in cooperation, make good use and contribute to unfolding and operationalisation.

In this chapter, we first gather the conclusions that emerged from our debates and the various research projects carried out in the CeiED. Later, a second part presents our positioning on key issues where, we believe, will help operationalise CS further in the future.

The investigation carried out by the group is based essentially on the review of the literature on Citizen Science, with the selection of some publications analysed individually in the debate sessions. These sessions allowed us to gather opinions from the different members of the group, who, because of their formation, necessarily have different approaches to the subject.

In addition, the analysis considered CIDATE's past and ongoing research projects, which, as source of experiences, allows a reflection on the importance of CS for a research project.

LESSONS LEARNT FROM OUR DEBATES AND OUR EXPERIENCES WITH CS

Conclusions from the debates of the CIDATE Working Group on CS

Whilst various definitions of Citizen Science coexist, the "**Ten principles of Citizen Science**" (see Table 1) (Robinson et al., 2018), from an operational perspective, seem to capture the main characteristics of CS. They are aimed at stressing what matters most when using CS in a project.

Table 1: The 10 principles of CS. Source: Robinson et al. (2018)

1. **Citizen Science projects actively involve citizens in scientific endeavour that generates new knowledge or understanding. Citizens may act as contributors, collaborators, or as project leader and have a meaningful role in the project.**
2. **Citizen Science projects have a genuine science outcome.** For example, answering a research question or informing conservation action, management decisions or environmental policy.
3. **Both the professional scientists and the citizen scientists benefit from taking part.** Benefits may include the publication of research outputs, learning opportunities, personal enjoyment, social benefits, satisfaction through contributing to scientific evidence e.g. to address local, national and international issues, and through that, the potential to influence policy.
4. **Citizen scientists may, if they wish, participate in multiple stages of the scientific process.** This may include developing the research question, designing the method, gathering, and analysing data, and communicating the

results.

5. **Citizen scientists receive feedback from the project.** For example, how their data are being used and what the research, policy or societal outcomes are.
6. **Citizen Science is considered a research approach like any other, with limitations and biases that should be considered and controlled for.** However, unlike traditional research approaches, citizen science provides opportunity for greater public engagement and democratisation of science.
7. **Citizen Science project data and meta-data are made publicly available and where possible, results are published in an open access format.** Data sharing may occur during or after the project, unless there are security or privacy concerns that prevent this.
8. **Citizen scientists are acknowledged in project results and publications.**
9. **Citizen Science programmes are evaluated for their scientific output, data quality, participant experience and wider societal or policy impact.**
10. **The leaders of Citizen Science projects take into consideration legal and ethical issues surrounding copyright, intellectual property, data sharing agreements, confidentiality, attribution, and the environmental impact of any activities.**

Although these principles constitute useful guidance, they are still, in our view, in need of careful discussion and potential revision. In particular:

Principle 1 states that citizens are actively involved. We would like to add that citizens do participate on a volunteering basis. If more and more citizens are to be involved in projects, in view of democratising research and decision-making, the issue of what motivates this people to volunteer becomes crucial and worth thinking about carefully if CS is to be successful and if volunteers are to stay involved until the end of a project. In Principle 1, besides, the use of the form 'may be involved' animates controversy: we felt that the element of uncertainty it carried could also impact on who could end up being 'a contributor, a collaborator or even a project leader'. This lack of clarity in choosing who participates and why can lead to a situation that generates inequality amongst participants and may favour some views (belonging to people with more confidence and/or more willingness to participate, or even more power) at the expense of others. In our view, the participation of citizens, although on a volunteering basis, must represent the reality of the diversity of society. CS projects would therefore benefit from inviting people to participate more actively in a more methodical way. For our working group, CS considers citizens as projects' co-creators and actively involved in all the process from the conception, through to discussing about appropriate activities to involve participants, strategies, and presenting the outputs of the project.

Principle 2, in our view, addresses the need and will to conciliate different perspectives. Reinforcement and valorisation of the citizens' participation brings parity between different opinions. Bringing citizens to project negotiations

enhances knowledge. Citizen's participation enlarges the knowledge of entire communities and can influence the social contexts within which they live. Having several brainstorming and working meetings with citizens and their communities that value co-creation can contribute to establishing collective strategic guidelines. The projects based on CS can influence social policies.

In the formulation of **Principle 3,** we feel that the verb 'should' ought to precede "benefit": there *should* be reciprocity, otherwise there is no motivation for citizens to participate. The researcher whose role is to facilitate the communication between all the social actors involved "with" and "in" the process of building a project needs to be very clear about the role of all the co-creators and citizens need to know that they are invited in every stage of the research.

As we explained earlier, the term 'if they wish' – used in **Principle 4** - could be problematic. It is important to be sure that cocreation is based on a horizontal hierarchy that states and reinforces that everyone is needed, and their opinions counts, in many ways. It should be noted that the participation of citizens in scientific activity can take place in the background and in a relatively discreet or even "silent" manner.

Concerning **Principle 5**, potential problems in communicating scientific results / 'translating' scientific into 'citizens' language' is an additional difficulty in the case of CS. One of the things that are pointed out at the beginning of CS projects is the fact that citizens are not only part of all the working process as co-creators and critical thinkers, but also as social actors of the research process related with collecting data and being able to explain them and use them.

Principle 6 addresses the fact that there are various research approaches/ methods used in CS. There could be more writings on this, maybe even in 'tool-kit' forms. CS works with research action approaches that are closer to the knowledge of the subjectivities and the meanings attributed by different social agents to a given phenomenon. This context will increase the democratization of science and, subsequently, the citizen's scientific literacy.

With regards to **Principle 7**, the issue of 'privacy' is key, especially in CS projects applied to social sciences. CS projects' data and meta-data are very important. Instruments used to collect information must guaranty respondents' anonymity and make sure that their responses will be coded in compliance with applicable data protection legislation. Answers should be analysed by the group instead of individually.

Concerning **Principle 8,** 'sensitive' projects (politically, for instance) may motivate citizens to remain anonymous. This type of situations may, and should, be considered carefully. In CS, participants should be able to choose to be acknowledged *or not*.

Concerning **Principle 9**, indeed the question must be discussed, and our view is that citizens do not *have to* be the leaders of the project. The project, to be validated by academics as a scientific project, must be certified as an intellectual piece that respects strict procedures concerning how science must be built. This implies that the project is led by a scientist.

Principle 10 highlights the fact that participants should be made sensitive to these ideas too: they must feel responsible for this, within the project – see also Principles 7 and 8.

Besides examining the 10 principles of CS, our working group organised **debates** around various readings, from which conclusions emerged as to how CS could be best used in the context of socio-spatial studies. Various approaches can be used, that present different advantages but also potential shortfalls. When examining the outcomes of the research being carried out in Amsterdam by Groen & Meys (2017), it was clear that the favoured *modus operandi* was to focus on **public participation through GIS mobile applications**, which should not be confused with the simple collection of information from citizens using new technologies (e.g. smart phones). In that research project, these apps were used with the aim of identifying (urban) places of pride and places in need of attention in selected neighbourhoods. These apps are also frequently used in the elaboration of movement traces that enables tracking and mapping of collective pedestrian and/or bicycle flow dynamics through a specific urban area[1], using methods from Space Syntax or Geography. The relative success or failure of the implementation of mobile GIS apps, and collaborative data practices in general, seems to lie in the preparatory phase in which the initiative is presented among potential collaborating citizens. It may not be enough to present the initiative through traditional channels and promotion materials (flyers, posters, letters, web sites), but rather to develop preparatory training sessions to inform them about the objectives of the project and how citizens will be involved in the processes of collection, treatment, and dissemination of the data. Above all, it is important to ensure the transparency of the process and the engagement of the participants, which can take time to raise awareness and involve citizens in the project. The holding of exploratory meetings, workshops, or interviews in the initial phase of the work can be useful in this context, in the sense that citizens may feel more engaged with the policy making process or academic research associated with the collaborative data collection. The bottom-up nature of many of these initiatives to gather information from citizens is questionable, especially when they have a political origin or motivation. It is not always clear to what extent the results obtained are incorporated into decision-making processes or into the final conclusions of an empirical research project. It is therefore essential to ensure evaluation mechanisms that allow citizens to verify how the data collected in the meantime has been incorporated in these processes and/or in the results of a participated research. These remarks point to the fact that participatory GIS, as one type of 'contributory CS', need to be carefully used for the scientific process to genuinely be participatory and for the outcomes to benefit all. In urban contexts, linking the 'hard science' characteristics of Contributory CS (data collection) with the social, human, cultural, political contexts within which these data are going to be used is fundamental. The 'how to do so' and 'to which end' really determine the participatory and inclusive nature of CS.

When exploring the work of Crain, Cooper and Dickinson (2014), the **interdisciplinarity of CS** was discussed. Often, CS is used in natural sciences to ensure that more realistic, on-the-ground data can be collected by citizens and shared. When it comes to social sciences projects, the 'data' required is more related to perspectives, private data on social conditions and backgrounds, for instance - generally data where 'privacy' really matters. Typically, social sciences are subdivided between those that are fundamentally based on empirical observation, such as Ethnography or History, and those that are dedicated to the

1 Example: http://cargocollective.com/citizendatalab/Participatory-Mapping/GoGoGo

construction of models, such as Sociology, Social Anthropology and Economics (Lévi-Strauss, 1963:286). Today, these differences are more blurred, with most social sciences being founded on empirical data collection and analysis, often in interdisciplinary dialogue. In this way, the methods used in CS may be of universal application to the social sciences, although it is recognized that they are most useful in ethnographic studies, in pictures of static activities (static snapshots), or in motion traces in the specific case of urban studies (Al Sayed et. al., 2014: 44-46). In addition, it is recognised that CS is not applicable to certain problems, namely those of an anthropological or economic nature in which scientific formulations of a theoretical nature prevail.

In our debate on the work of Silva, Aboim & Saraiva (2008), what also became apparent is that people living in cities and potentially exposed to associative movements were probably more likely to both understand the objectives of CS projects and keen to participate. If mobilizing citizens for political, civic or fundraising demonstrations seems to be easier in urban areas, rather than in the countryside or in small towns or villages, it might then be easier to carry out research activities in urban planning using CS in medium-sized cities with higher education institutions that could act as local partners. However, this raises the issue of the need to "train" people in advance to carry out a CS project, i.e. to guarantee genuine inclusion. If participation is carried out only by those who are used to participate, a bias is introduced into the research from the beginning.

Urban agriculture (UA) is a good example of building links between rural and urban worlds, a subject discussed on the basis of the article of Pollard et al. (2017). The topic of UA in the Lisbon Metropolitan Area requires a meticulous analysis using different perspectives, knowledge, and practices that bridge natural and social sciences. UA is sometimes confused as a playful or trendy activity of the middle class, when in fact the "*hortas*" (vegetable gardens) are an ancient popular culture of the people from Lisbon and its immediate surroundings. Such activities resulted in the common nickname "*Alfacinhas*" (lit. '*small lettuces'*) given to people from Lisbon, presumably because they used to grow them in their gardens. With the rural exodus intensified in the 1950s and 1960s, UA acquired more complex contours, mixing several motivations: food self-sufficiency, reproduction of habits brought from the countryside, leisure activities. It also became a problem of territorial planning through the systematic occupation of the public water domains and river margins, amplifying the risks of pollution, flooding and instability of slopes, often in association with urban areas of illegal origin (AUGI[2]). Beyond these problems, UA can, on the contrary, provide solutions through improved food security, diet, mental health, social cohesion, CO2 absorption, increased biodiversity, a more coherent food system and green infrastructure, to name few. All these relate to the various dimensions of 'urban sustainability' – a concept which loses its meaning if city dwellers are not taking part in defining and operationalising it. The debated around Pollard et al. (2017) revealed that although much action and participatory measures in agriculture research are carried out, very few of these projects see themselves as related to CS *per se*. In the research project presented in the paper, focused on water usage in UA, the authors stressed the necessity to train participants, making them able to calculate

[2] Áreas urbanas de génese ilegal - https://www.lisboa.pt/cidade/urbanismo/planeamento-urbano/areas-urbanas-de-genese-ilegal

and communicate data correctly, as well as to make potential use of these data once collectively shared. In other contexts, especially in a European one, food security is a growing issue that affects urban planning, the distribution of various economic activities within this specified space, the need for an environmental balance between built and green areas, and the co-creation of urban public places. It relates to the food system of the city and therefore to the city as a human-natural ecosystem. The bottom line is that enhancing food security at the city level cannot be done without the participation of its citizens through a 'social urbanism' process. What the UA example highlights is that CS is an ongoing learning process that enables perspectives and needs to be constantly new defined and integrated into a global and more consensual urban strategy.

Experiences on CS from research activities

CeiED and CIDATE have in their flagship the goal to extending knowledge on CS and how to make use of it in their strategic mission. Increasing knowledge of CS requires a better understanding of its architecture and learning effects. CIDATE is already involved in research projects that are spurting some experiences and lessons on CS.

> **Placemaking with teenagers** was a case study from the **Project C3Places**[3] dedicated to advancing knowledge on the spatial practices of young people through the help of digital and mobile technologies. The case study in Lisbon focused on teenage students (aged 13-18), and on working out with them the design of a public space in the Alvalade neighbourhood. Teenagers were engaged in different urban leaving labs (Bylund et al., 2020), aimed at the co-creation of public spaces that meets teenagers' needs and preferences; and with this establish a teenagers' sensitive public space.

1. The advancements of digital and mobile technologies open new ways to increase research and engage with stakeholders, creating therefore new participatory dynamics. In Lisbon, the project enriched the understandings of the relationships between spaces and social behaviour from teenagers' lens.
2. Although Alvalade is a paradigmatic neighbourhood, planned according to a modernist Master Plan with plenty of open spaces, the neighbourhood lacks an appropriate infrastructure to provide adequate opportunities for young people to socialise and interact outdoors.
3. The research programme encompassed different methods and tools, such as thematic workshops, exploratory site visits in the neighbourhood, discussions and debates sessions and surveys undertaken and analysed by the students. Living labs were complemented with other methods and techniques of data collection, such as collaborative ethnography, space observations and interviews with local experts. Such a wide range of tools provided a manifold and interesting interpretation of placemaking with teenagers.
4. By exposing the students to co-creation and participatory processes, C3Places opened a forum for discussing inclusiveness and sociability, making them aware that they can have a voice in the decision-making that affect their environment.

[3] www.c3places.eu

Urban Agriculture (UA) **in the Lisbon Metropolitan Area** - much research has been already conducted in Portugal on this subject (Oliveira and Morgado, 2016; Delgado, 2018; Dias & Marat-Mendes, 2020; Marat-Mendes et al., 2021) and what now needs to be done is to link the various initiatives into a broader, more holistic, food system strategy for the city and to ensure that the urban governance leading to doing so is participatory. Our project therefore concentrates on responding to this need by developing a participatory governance tool aimed at encouraging a network of UA initiatives to increase the food security of the city and to help its citizens to both understand better what makes a city 'sustainable and resilient' and to take part in its transformation.

Various lessons have emerged from the ongoing work:

1 The current COVID-19 crisis together with efforts to develop social urbanism and 'sustainable cities' lead to some conclusions: i) research in UA can be useful for reasons related to health, nutrition, urban planning and social cohesion; ii) CS can help us gain an overall understanding of these issues through the perspectives of different stakeholders. Encouraging social and territorial learning, the co-creation of urban places and the expression of different perspectives can be improved through the use of CS.

2 CS goes well beyond 'Contributory CS' in this project: considering the 'reciprocity of CS', it must be included in the design of the CS methodology used in a project expected to build good participatory incentives and good retention. Similarly, issues of trust and data privacy need to be made very clear and addressed collectively from the beginning.

3 For the efficient use of CS, a project should not only lead to generating convincing data, but consider that small-scale, diversified types of UA initiatives can help consolidate food security. It also should lead to a data-collecting process and the collective construction of a better urban governance tool. To do so, it suggests using Soft Systems methods and Adaptive Management in conjunction with CS.

4 One of the major differences between participatory research approaches in agricultural projects and CS approaches is the use of digital tools – enhanced during confinement periods but also acting as an important constraint when various and numerous stakeholders are involved. Building the appropriate interactive participatory online platform will use a MURAL, design thinking method aimed at facilitating collaboration and negotiations.

CyberParks Project[4], was a COST Action aimed at improving the knowledge about the challenging relationship between people, spaces and digital technology, and the production of more inclusive and cohesive urban spaces. The application WAY CyberParks (web and mobile app) was developed and tested as a digital tool that enable to monitor the way people use public spaces. It also acts as an interface for exchange between users and planners, thus contributing to an increase in the understanding of users' spatial needs and preferences. Some workshops were carried out in public places, such as parks,

[4] www.cyberparks-project.eu

gardens and squares, where the participants were asked not only about the places but also about the user-friendliness of the application.

The lessons learned from getting people involved in placemaking are related to:

1. Easing the data collection, particularly of qualitative data and improving the speed of their analysis.
2. The digital literacy of users and intuitive use of the app, ultimately helped to shape the outcomes.
3. The experiences allow us to conclude that the use of digital tools in engaging with people, besides providing meaningful data, also enabled people to gain knowledge about urban (planning) issues.

verDEsporto[5] explores, through an interdisciplinary and transversal approach, the appropriation of green spaces by physical and sport activities practitioners and the influence of the COVID-19 pandemic context in these dynamics. Supported by the principles of CS and co-research, verDEsporto aims at carrying out an integrative analysis of this social phenomenon, considering the participation of different strategic thinking of two different central agents (community and decision-makers). The main focus is to analyse the usage, needs, behaviours and values associated with the appropriation and physical activities practices in greenspaces by different population groups. To reflect on the use, and appropriation, of the territory for the construction of more participatory, active and sustainable societies, different issues have to be taken into consideration, such as non-formal education, sociocultural significance of physical activities outdoors, quality of outdoor spaces. The methodology was co-developed by stakeholders and students (from Sports and Urban Planning) involved in the research.

Although the empirical part had just started (as of November 2021) some lessons can already be drawn:

1. The COVID-19 restrictions have forced people to interact with immediate surroundings in new ways – so people are more aware about a healthier environment.
2. The observation of physical activities in greenspaces and the analysis of the impact of lockdown on exercise levels requires mapping current conditions from a broad public.
3. The working methods (participant observation, interviews and field diary) were widely discussed with relevant stakeholders on online meetings.
4. The usage of public greenspaces and the link between nature and wellbeing is a starting point for cities to understand where investment in nature is most needed.

Outcomes from the 11th CeiED researchers' workshop

In July 2021, the annual research meeting of CeiED involving the three areas of its PhD programmes (education, urban planning and museology) focused on CS.

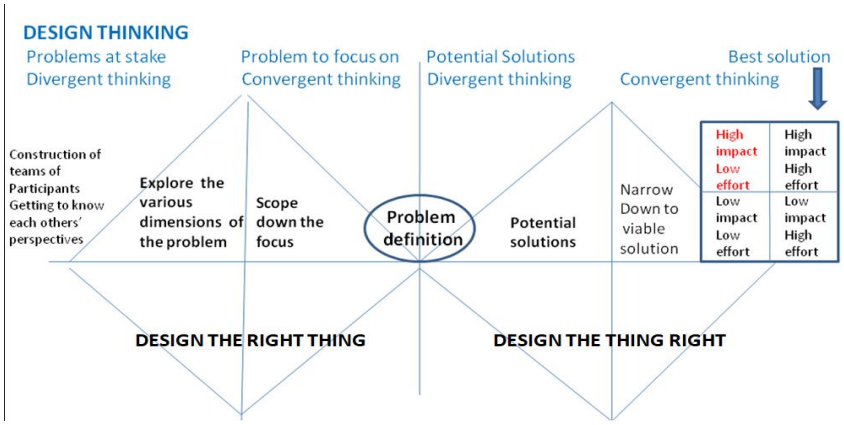
[5] https://www.ceied.ulusofona.pt/en/directory-research/projects/verdesporto-en/

Entitled *'From Citizen Scientist to Citizen Science: Crossed Perspectives in the Construction of Knowledge*', it encompassed, on top of plenary sessions, a visual art exhibition, a series of parallel sessions dedicated to PhD researchers and a one-day Design Thinking workshop (hackathon).

Three core lessons and practical recommendations can be derived from the debates: 1) CS is an umbrella platform under which incipient issues and "old acquaintances" emerge and overlap, 2) The discussion stressed the importance of participatory approaches in all three areas (education, museology and urban planning), and 3) to face the challenges and opportunities that are not emerging, digital advancements can be useful for the production of knowledge. The latest is especially important as digital and mobile technologies are increasingly becoming ubiquitous, and their usage is becoming more than task- and work-related, as pointed out in Smaniotto et al. (2019). Digital and mobile technologies are opening opportunities to facilitate participatory processes; this is associated with both positive and problematic aspects, such as lack of access to technologies and unequal perception of ICTs' potentials.

The Hackathon

The literature on CS actually highlights that there are various interpretations of CS (Eitzel et al, 2017) and, also, that there is not 'one right way' of carrying it out. Since CeiED has not developed a specific CS approach, one of its objectives is to further explore how research can contribute to CS as well as how existing CS tools can be used. As Design Thinking is considered a promising tool (Brown, 2019), it was used to 'experiment with' in the hackathon. Design Thinking provides guidance on how to define a problem (by refining its definition and better understanding various stakeholders' perspectives on it), and to identify a potential solution that responds to people's needs (Brown, 2019). The idea behind this methodology is to carry out a participatory process that engages stakeholders in problem solving and solution finding, and to identify which specific aspects of the problem people should focus on and why. This process leads to the identification of the solution with the highest impact and lowest effort. The 'Double diamond model' (Figure 1) is generally used to visualise the Design Thinking process, and to better grasp the idea of how we move between divergent and convergent thinking, i.e. first to understand the problem and then to find a solution.



3.1

Figure 1: The use of Design Thinking to identify high impact – low effort solutions. Source: adapted from Brown (2017) and service design Academy (www.sda.ac.uk).

This approach was used in the hackathon, in groups of seven people in average. Each team was made out of students from different disciplines and levels, supported by a facilitator. Since it was an international online event via zoom, the online collaborative whiteboard ('mural') was used. Participants could communicate orally or write down directly onto the 'mural' their thoughts and suggestions. For each team, an own "mural" page was created. A scenario, summarised in Table 2, was prepared and suggested to participants to focus on.

Table 1: Scenario selected for the hackathon

The global pandemic forces us to rethink how we live together and how we share common spaces, like the university campus, for example. While we have developed strategies for teaching and learning with a variety of online tools, the college campus experience continues to be important to the academic community. It is equally important that we take advantage of all the potential that technological tools offer us. Within higher education, face-to-face and online approaches need to be carefully balanced so that the experience is enjoyable, productive, reflective and social. These precious years also need to encourage students to gain individual and professional confidence as they find their place within the young adult community and progressively build a professional network. While it is possible to learn at a distance, individually and even collectively, are we not missing some important dimensions arising from the experiences of "physically learning together"? What will be the new role of the university campus as a physical space in this new context of return to presence? We are invited to reflect on the various problems that going back to the university campus raises.

The role of the facilitator proved to be crucial since negotiation is the key to the whole process. People need to clearly express their statement(s) and idea(s), and to also be able to ask others for clarifications. Despite the fact that the mural is quite intuitive and easy to use, this modus operandi is not familiar to everyone and occasionally need to be further explained. Interestingly, creativity requires time - sometimes more than expected, since the familiarity with digital tools vary, and for this reason it was expected that the more familiarised would open up their imagination and contribute with 'as many ideas as possible'. Self-imposed limitations or constraints enforced by society or others, often reduce the range of imagined or expected options and scenarios. Developing the 'divergent thinking' phase, whilst staying focused on the issues at stake, is an exercise. 'Converging' seems more in our habits, even though both selecting one specific problem and then, later, one specific solution, still presents its own difficulties – notably that of remaining within the remit of the scenario originally presented. There is a high level of subjectivity both in the reduction of all inter-connected problems characteristic of the presented scenario and in the presentation of potential solutions as well in the selection of the high-impact/ low-effort solution. Further

research could be carried out to better document these choices and, of course, a Citizen Science project would not, a priori, exclude this.

Under this guise, the following issues are identified and underlines the need:

- To re-examine the philosophy and methodology at the base of education, urban planning and museology. The awareness of these needs and the principle to return the results of studies and research to the society, calls for improving education and setting CS into a reflecting pedagogy, both reinforce the multidimensional nature of CS.
- To involve the community in processes of collecting, interpreting and reflecting on decisions and actions related to them, since the construction of the city, society and care for the environment are issues that concern every single person.
- To deconstruct adult-centred actions and to explore the agency of vulnerable groups, such as children, elderly, native peoples, minorities, etc, for a more complex and wealthier socio-spatial development.
- To recognise collective practices as an efficient way to empower disadvantaged communities, i.e. in environmental activities. Such projects can develop social relevance (through the visual and thematic content they produce and through the collective bond they create) and deliver important working principles for CS.

KEY ISSUES AND RECOMMENDATIONS TO OPERATIONALISE CITIZEN SCIENCE IN SOCIO-SPATIAL STUDIES

Armed with the above discussed insights, and with the conclusions from the several debates of the Working Group on Citizen Science, we then scanned some key issues for on-going and forward-looking debates on CS. These key issues encompass the drivers and their components: STAKEHOLDERS, MOTIVATION, INTERDISCIPLINARITY, RECIPROCITY, LOCAL KNOWLEDGE and PLACEMAKING AND USE OF DIGITAL TECHNOLOGY. The identified key crucial issues that drive a process of active cooperation and open up new cooperation fields. In socio-spatial studies, they also help the development of new research methods and contribute to a discussion of experiences gained in practice. Figure 2 depicts these key issues and the main outcomes of their interaction. It is evident that, as far as value adding process are concerned, the previously stated arguments show that keeping the focus on isolated factors/approaches do not result in innovation and interdisciplinary knowledge. An interaction between these components can elucidate locally rooted needs while generating creative ideas and evidences that help the development of new research models.

Figure 2: Key issues for on-going and forward looking debates on CS in socio-spatial studies

On the power of interdisciplinarity: CS and the relationship between social, humanities sciences and natural, hard sciences

CS based on participatory methods of investigation has evolved through multiple manifestations in different areas of knowledge. Social and human sciences, focused on the dynamics that involve various processes of construction, production, and reproduction of social structures in contemporary societies, aim to improve a broad understanding of different spheres of social action. As such, Social Sciences are great contributors of knowledge in structuring the foundations, modalities, and scientific and social scope of the construction of projects related with CS, opening the methodological spectrum with new approaches associated with the active participation of the various stakeholders that share the social space. The contribution of social sciences is strongly related to the enrichment of CS since it improves our knowledge of social structures and practices. The construction of social interventions in different areas - such as territory, urban design, education, sport, etc. - should be an action purpose informed by co-operation in different institutional and organizational frameworks. The association between social and hard sciences must be dialogical, in a context were both complement each other, and where different values and practices come together for building knowledge trough critical reflexivity. Participatory innovation (Hecker et al., 2018 in Tauginienė et al., 2020) associated with an action research process that is closer to the knowledge of the subjectivities and the meanings attributed by different social agents to a given phenomenon, will allow the democratisation of science. Social sciences tend to make co-creation and co-reflexivity a socially efficient way to generate knowledge, a powerful testimony for the need of their inclusion in CS. The relation between social, humanities sciences and natural, hard sciences should not be by opposing different scientific ways of observing, studying, and presenting results about a certain phenomenon, as if they were irreconcilable. They must be seen as a consistent and powerful interdisciplinary way of contributing to Citizen Science, where each one can add and co-create valuable information and knowledge. This strategy enriches the processes, the actors, and the co-creation of scientific knowledge, once it amalgamates in an integrative way the effects, outcomes, impacts, and reality in question.

On the nature of research stakeholders

The ECSA first principle of CS establishes that "*citizens may act as contributors, collaborators, or as project leaders and have a meaningful role in the project*" (Robinson et al., 2018). The leadership by a citizen may occur, but in exceptional cases - when she/he has a unique experience in the research subject, or a compatible profile (i.e. an honorary doctorate or highly recognised prize). Nevertheless, a citizen that leads research in a non-university organisation might be able to coordinate scientific research, even if not being affiliated with a high education institution.

Hillier (2007: 194-195) uses two categories to divide knowledge: i) *scientific knowledge* which is related with explicit abstract principles, and ii) *social knowledge* which is a set of implicit rules that allow us to act socially in well-defined ways. The former is associated typically with universities and the latter with social organisations including private companies. Nevertheless, companies and other similar organisations – such private foundations can produce scientific and technological knowledge in a systematic way. In fact, the advancement of science and technology depends upon the efforts not only of universities, but also of research and development departments or laboratories of companies, NGOs and

other specific entities such as military/armed forces. Classic examples of innovation in non-university institutions can be found in the Bell labs (USA) - where the programming languages C and S (later R) were developed, the US Air Force Rand project that hosted the pioneering works of Richard Bellman in Dynamic Programming, or the Fraunhofer Foundation (Germany), where several innovative technologies have been developed, like the MP3 music compression algorithm. Another key example is fine chemistry whose advancements and innovation are essentially carried out by the pharmaceutical industry, sometimes in partnership with universities, and with the protection of patent systems, as suggested by the recent swift development of COVID-19 vaccines. In Portugal, there are two private foundations (Gulbenkian[6] & Champalimaud) with remarkable record on biomedical research, and both make use of Citizen Science practices.

The collaboration between universities and private companies is particularly relevant in data science field. On the one hand, tech companies need the high-level scientific knowledge in mathematics, statistics and economics that only academics can provide to implement machine and deep learning algorithms. The hires of Hal Varian (former professor of Economics at the University of California, Berkeley) as chief economist at Google, and Matt Taddy (former professor of Econometrics and Statistics at the University of Chicago) as vice president of Amazon are good examples of that trend. On the other hand, academics need the big data that private companies can easily provide and handle. As a matter of fact, the most innovative companies in data and technological areas are often spinoffs originating from universities. Companies like Alphabet (Google) or Facebook regularly publish scientific articles with their own methodologies and relevant scientific results[7], a phenomenon that is already observed in Portugal (e.g. Closer).

In summary, citizens can lead collaborative (data) science projects, if they belong to and eventually lead research teams in relevant organisations such as foundations, private labs or technological companies that work closely with universities, or with former professors and high-level academic researchers, eventually with the active involvement of citizens.

On the importance of reciprocity

The acknowledgement of citizens' participation, in the presentation of the research outcomes, is one characteristic of CS. Although sometimes it is impossible to quote every single participant when samples are particularly large, CS makes a point of valuing the work carried out by participants. In doing so, without fully conferring the status of 'researchers' *per se* to the participants, CS nevertheless recognises the importance of their contribution, knowledge, know-how and perspectives. If such recognition is important for some participants, some others (citizens who, in the past, have been nearly systematically denied a voice, in particular) might interpret it in a different light. When it is the case, a high level of mistrust and scepticism might de-incentivise them to participate in a CS-based project. Their starting-point question will remain: 'What's in it for me?'

[6]Science Gulbenkian promote several initiatives (in partnerships) as the starting point for well-informed and participative citizens and change-makers towards a more healthy, sustainable and resilient future, (https://gulbenkian.pt/ciencia/science-society/citizen-science)

[7]Example of a paper publish by Facebook's employees: Taylor S. J. & Letham, B. (2017). Forecasting at scale. PeerJ Preprints, 5. https://doi.org/10.7287/peerj.preprints.3190v2; https://facebook.github.io/prophet/

If advocates of CS approaches have realised that citizens can very usefully contribute to their work by enhancing the quality of the output and ensuring that their projects are more successful in the long-run, the reciprocal is not necessarily true. In order to participate in CS projects, in order to be trained - if needed - and to remain active during the whole project, citizens need to feel that the whole enterprise is also useful for themselves. This level of 'usefulness in return', this 'reciprocity' (Hetland, 2020; Davis et al., 2017), is related not only to the level of trust within the research team, but also to the ability of the research facilitator to help with conflict resolution and negotiation. This is crucial to ensure that all participants can learn from each other's potentially differing perspectives and appreciate the value of such exchanges and learning.

Reciprocity can also foster participants' willingness to expand the level of participation beyond the provision of data and, in turn, increase the impact either at the decision-making level or within the design of the research project itself. On this last point, many participatory projects in agronomy in less industrialised countries of the South, have worked with 'from-the-ground' knowledge because it proved more enlightened than other modern 'scientific' approaches - because they are better adapted to the local territory and its socio-ecological constraints. In such cases, farmers would completely change the way in which researchers had initially planned to carry out a project. Such rather exceptional events are becoming more frequent, especially in domains where a practical knowledge of the territory is needed and when the status of 'expert' is being questioned. Many areas of research in socio-spatial studies fit this category.

On the motivation to participate in CS

The best way to help CS projects to motivate people to participate are practical results generated by these projects. Usually, people who become participants are those who best know the history and experience of the places and communities they come from. If their participation is valuable to projects, they need to both understand that their participation is being valued and also be motivated by the fact that the project will ultimately be beneficial to them and their community.

CS has many potential benefits for science and its participants. To achieve these myriad of benefits, however, participants need to be recruited and, preferably, retained in projects. Recruiting and retaining participants can be costly and time-consuming (Merenlender et al., 2016; Wald, Longo and Dobell, 2016). Hence, it is not only enough for citizens to participate, but their participation must also contribute to the main scientific goal of the project. Participants' life experiences can be diverse. This can enrich CS projects and make them more successful. CS organisers who are responsible for recruiting people should first carefully identify which person or group will participate, according to their skills and life experiences, background, age, gender, skills, so that the project's result is more inclusive. In terms of participation, younger people might be keener to participate in view of acquiring knowledge, while older people's motivation to participate might lie in transferring knowledge. Another important dimension of participation lies in the fact that people from rural areas participate in a different way than people from urban areas, due to their less extended academic background and the very different social context within which they live and communicate with others.

Participation is influenced by CS project organisers' selection, therefore selecting participants is an integral part and crucial issue for the success of CS projects

(West & Pateman, 2016). When participation is done voluntarily, the tendency is for participants to have greater involvement in the project because it usually involves factors of personal interests, contrary to organisational initiatives that primarily serve the interests of the organisation and consequently may attract less participants. If participation derives from people's own decision and motivation, the projects' result will more likely be reliable and sustainable.

Several factors motivate people to retain participating in projects. One of them is when people identify themselves with ongoing projects, another factor is when people have already been heard in the past and see their contributions being considered or implemented. In some cases, participation is done for socioeconomic reasons, in which people participate to receive some benefits such as food, monetary rewards, shelter, etc. It should be noted that this type of attitude can vary according to the country, culture, religion, etc. One area that deserves special attention is how different types of motivation differ across demographic groups. This is important because some demographic groups (at least in Western countries) are under-represented in CS, with issues as gender, age, ethnicity, literacy, and socioeconomic status affecting the probability of participation (Nasem 2018; Pateman et al., 2021)

To persuade participants to continue to participate in projects, CS organisers must create metrics to analyse the evolution of satisfaction of these people on a regular basis. These studies can be done through social-psychological analyses of the participants, questionnaires, case studies, etc. When studies are being conducted, CS organisers must have a basic prior knowledge of the areas being studied. This can considerably reduce research time and also allows the projects' organisers to identify in which ways and in relation to which specific issues, the project might benefit the participants. According to Maslow's pyramid (Maslow, 1943; 1954), physiological needs must be met first: if people are facing difficulties, whether basic, security, or even self-esteem, their form of participation also varies. CS projects' organisers should pay attention to which stage of motivation participants belong during and after being interviewed. This will help in framing specific methods of participation according to participants stage of motivation. Thus, for instance, participants looking for ways of meeting their basic needs should be integrated in CS projects at different stages than participants seeking self-realisation.

Paying heed to the range of motivations of potential participants will increase the number of people taking part, as people will only begin and sustain participation in projects that meet their motivations (West & Pateman, 2016). Finding out the level of satisfaction of participants enables the design of tailored recruitment and retention strategies.

On making use of participants' local knowledge

Some people and groups of people are more likely to participate in CS, and the degree of participation is associated with some factors, such as the level of education, professional and political areas and the urban dimension in which they operate (Silva et al., 2008). As a rule, associations have a more significant number of members the greater their geographic coverage, and political parties that have more members in large urban agglomerations. In these cases, public participation, in the form of mobilisation and associative activities, tends to be greater due to more and enhanced information. This is because the people involved belong to

organised groups, and the level of collective knowledge is necessarily superior to that of an individual alone. These groups of people seem to benefit from more formal participation. Professional work also seems to be linked to greater self-mobilization for public participation, and the level of education is also a factor of involvement (Pateman et al., 2021).

Linked to participants and their motivation is their local knowledge, which is an intrinsic component of CS and placemaking. Local knowledge is defined by FAO (2006) as the knowledge and practices people developed over time and continue to develop. It encompasses dynamic know-how and skills of people or their community, adapted to local culture and environment. All this makes local knowledge inextricably linked to the involvement of local communities in CS projects. For sure, local knowledge is being challenged by technology advancements, so that there is a call for blending local-global knowledge and for crafting strategies to manage knowledge in a global context.

Citizen Science, placemaking and the use of new technologies

CS and placemaking are closely linked: both involve the incorporation of different stakeholders in their approaches to enrich the results. Besides promoting active engagement, both approaches also help increasing diversity, improving legitimacy and expanding local knowledge. Both are multi-disciplinary concerns. Whilst placemaking has its key focus on spatial planning (Strydom et al., 2018), CS can be used in different disciplines and studies (West, Dyke & Pateman, 2021; Pateman et al., 2021). Their amalgamation in planning issues enhances the socio-spatial connections (Toomey et al., 2020). An indelible relationship between CS and placemaking means also that the network grows as the linkages are strengthened. This means there is a strong connection between increasing participation opportunities, improving community resilience, responsive decision making and place-based learning. The latest relates to a deeper understanding of making places, i.e. creating quality urban environments that provide pathways for quality of life and sustainability considerations.

Keeping the focus on research, both CS and placemaking help creating good science and deepening our understanding of the social and spatial relationships. In this way, people's needs concerning spaces as well as their experiences and views, can be put onto centre stage. This is particularly important when taking the case of groups considered vulnerable - such as children, teenagers, persons with disabilities, migrants, elderly, to name a few. Working with vulnerable groups opens for them the opportunity to raise their voices - that are otherwise overlooked (Smaniotto et al, 2020). Empowerment (of individuals and groups) is thus a main target of both CS and placemaking approaches. Cooperation, information sharing, and education enable attaining new levels of personal and social awareness (Strydom et al., 2018). The authors point out that placemaking should not be focussed only on achieving an end-product, the process of empowering people itself is a relevant outcome. This is also true for CS, where the process of empowerment creates positive social change and enables individuals and groups to take action. This not only provides new perspectives and supports constructive debate but also makes sure that the active participation of

citizens in the making of the city becomes more inclusive and that, in turn, it positively affects their quality of life.

Engaging and empowering indicate an active support in achieving what Ringas & Christopoulou (2015) call transforming a city into a Sociable Smart City. An intensive and ubiquitous use of information (from local to global), through digital and mobile technology is changing our perception of time and space. More and more digital and mobile technology and devices are creating sociability (interactions) through a virtual space, transforming our physical world into a hybrid form (Smaniotto et al., 2019). This hybrid space is being described and represented through digital technologies and their applications gave birth to smart cities, where data and digital technology are used to improve efficiency in the use of resources and services and, lastly, to improve the quality of life. As digital and mobile technologies continue to change our social dynamics, they simultaneously drive changes in spaces we use daily (Zammit et al., 2019). The lure of the smart city is however being faded away by the trust that technological fixes alone can solve our problems and respond to our social needs.

There is no doubt that digital and mobile technology, along with artificial intelligence, provides opportunities to elicit and understand urban-social dynamics and enhance the connections between them. The call is however to also develop, besides the IoT (Internet of Things), an Internet of Nature (IoN) - as pleaded by Galle et al. (2019). According to the authors, heed has to be taken of the natural capital upon which cities rely, as there is the risk for it (the nature) to be left behind by the digital revolution. Even in the digital era, the contact to nature and to the other is an essential part of well-being (Smaniotto et al., 2019). Such a dynamic process as the digital advancements poses some questions such as how emerging technologies can improve urban ecosystems, and how to transform our environment into biophilic cities (Wilson, 1984; Biophilic Cities, n.d.). For this reason, smart citizens and in particular smart governance will be the cornerstone of a transition that will encourage creative participation and agency, and will put people and nature-based solutions at the forefront of transformations. The question is how to embrace the opportunities and challenges of leveraging digital advancements to engage and drive local communities into smart, equitable and sustainable urban transition. The central challenge remains how to make use of digital technologies to transform our cities into interactive landscapes, encouraging engagement and better social environments, supporting sustainability, responsibility and knowledge about nature, people and the city. At the end of the day, technology must make sense and must bring an added value for the environment and people (Smaniotto et al., 2019).

Therefore, both placemaking and CS invite stakeholders to be both opportunistic and strategic in improving existing and in creating new urban environments. Both have the potential to test and trial innovations in social and spatial senses. The outcomes are manifold, ranging from new forms of interactions, responsive places, and increase in the sense of identity to attracting users and community ownership, and sharing of responsibilities in the management of collective goods. In research, the outcomes emerging from CS and placemaking can be used as

evidence to show that these approaches result in better informed public policies and agendas.

KEY MESSAGES

Socio-spatial studies and CS approaches have their strengths and can greatly complement one another.

CS with community participation ensures the improvement of local data in socio-spatial studies, and better fundament information to decision making.

CS opens the opportunity to involve different stakeholders and, in particular, to explore the agency of vulnerable groups, such as children, elderly, native peoples, minorities, etc, for a more complex and wealthier socio-spatial development.

CS calls to establish the dialogue and sensitive listening between all parts. This is associated to the call for crafting dialogue strategies and joint activities with different stakeholders, in order to foster and enhance mixed types of learning.

The outcomes emerging from CS need to be tailored as evidence to show that these approaches result in better informed public policies and agenda.

CS can help ensure that processes are participatory. This calls for establishing local coalitions backed by a global strategy.

CS, as community collaborative-based approach, helps promote community development and territorial capacity.

CS, as any other approach at the end of the day, must make sense and has to bring an added value for the environment and communities.

CS engage citizens in data collection, resulting in a significant gain in knowledge for researchers.

CS allows the results of an investigation to be more reliable and locally rooted.

CS to be successful must provide citizens the necessary tools and knowledge from beginning of the investigation.

Communication between all parties should be simple, objective and easy to understand.

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