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Citizen science at universities: Trends, guidelines and recommendations

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Contents

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About LERU

LERU was founded in 2002 as an association of research-intensive universities sharing the values of high-quality teaching in an environment of internationally competitive research. The League is committed to: education through an awareness of the frontiers of human understanding; the creation of new knowledge through basic research, which is the ultimate source of innovation in society; the promotion of research across a broad front, which creates a unique capacity to reconfigure activities in response to new opportunities and problems. The purpose of the League is to advocate these values, to influence policy in Europe and to develop best practice through mutual exchange of experience.

Executive summary

Citizen science, the active involvement of non-professional scientists in research, is experiencing an upsurge of interest. Activities range from small projects by groups with a common interest to large international projects, which involve professional scientists and research institutions. Citizen science can involve a vast range of activities, from gathering data in remote regions of the planet to crowdsourcing over the internet. Smart phones and other low-cost instruments are opening up new opportunities for public engagement with research. Thus scientists at many LERU universities and elsewhere are actively involved in managing citizen science projects in various domains.

The League of European Research Universities (LERU) recognises the potential of citizen science for research and its role in the open science movement. LERU is aware that modern IT technologies enable citizens to engage in monitoring pollution, collecting data on biodiversity, language studies as well as many other research activities. LERU's commitment to tracking important trends in research, advising on them and encouraging a productive relationship between science and society motivates this paper.

The purpose of this paper is twofold: First, it provides a set of actionable guidelines for professional scientists engaging in citizen science at universities, thus helping to ensure high quality research results of citizen science projects and encouraging efficient collaboration between professional scientists and the public. Second, based on these guidelines, this paper provides a series of policy recommendations for universities, research funding organisations and policy-making bodies to promote excellence in citizen science.

Given the diversity of citizen science, no simple set of guidelines can accurately and exhaustively describe all the challenges that a professional scientist may face when planning and running a citizen science project. Still, through concrete examples and references to pertinent literature on the subject, we document good practice at LERU universities and elsewhere, raise awareness about some of the major obstacles and pitfalls, and dispel some popular misconceptions about citizen science.

The paper begins with an introduction to the history and state-of-the-art of citizen science. We observe that the number and scope of citizen science projects are increasing due to the widening interest of citizens in science, the growing availability of advanced communication technologies, and increasing concerns about various issues of general interest such as environmental sustainability and cultural heritage conservation. Furthermore, governments are increasingly interested in strengthening citizen involvement in science projects for education. In addition to these trends, the European Commission is advocating strongly for an open science agenda, of which citizen science is an important element.

Second, this paper highlights some recent developments in citizen science projects run by professional scientists at universities. We distinguish three important trends:

1. Increasing coordination and collaboration between citizen science practitioners from different fields, which leads to sharing procedures and best practices, and to the creation of networks and associations.
2. Emergence of platforms that support a variety of citizen science projects, creating broader public awareness and encouraging a greater retention of volunteers.
3. Expanding the role played by citizens in the projects beyond simple tasks to include greater participation in all phases of the research process from conceptualisation to publication.

To contextualise these trends at the national and international level, this paper also addresses the role of organisations for citizen science, which embrace an increasing activity outside academia with variable relationships to universities. The paper also hints at possible future directions of collaboration for these organisations and research universities.

Third, this paper lists some important success factors common to many existing citizen science projects, and summarises these as a set of succinct guidelines for professional scientists planning citizen science projects at universities. These guidelines cover the following seven themes: recruitment and retention of participants; quality and impact of the resulting research; opportunities for informal learning and scientific creativity; openness and transparency; questions of organisation, information flow and sustainability; appropriate credit and rewards; and ethical and legal considerations.

Based on these guidelines and recent trends in citizen science, the paper concludes with a set of recommendations for LERU and other universities, for research funding organisations and for policy making bodies.

Guidelines for scientists

1. When designing a citizen science project, researchers should plan for substantial and sustained investment in outreach and community management, to ensure adequate numbers and diversity in the citizen science community that will participate in the project.
2. Researchers planning citizen science projects should clearly define the impact they aim to have at the outset of the project, as well as track and regularly communicate to the participants progress towards this impact, or deviations that may occur, through a broad range of indicators, from scientific publications to more popular forms of dissemination.
3. Where feasible, projects should be designed to encourage all participants fully to contribute their talents and creativity, to grow their skills and responsibilities within the project, and to increase their knowledge of the related science in a pedagogically sound way.
4. Researchers developing citizen science projects should adopt open science standards consistent with their institutional policies, including open access publication, open data standards, open source software, and extending to full transparency of research methods.
5. Citizen science projects require appropriate organisational and oversight structures to represent the interests of all stakeholders, codes of conduct to ensure respectful communication between all participants, and a long-term data preservation plan that enables open access to results and data, ideally sustainable beyond the end of the project.
6. Citizen participation should be recognised properly, for example through acknowledgement or co-authorship in publications where appropriate, through motivational rewards and through a credit system that enables tracking of contributions.
7. Researchers should provide clear terms and conditions to participating citizen scientists consistent with both open science and personal privacy requirements. Where useful to the project, citizens may be involved in decision making aspects. Where appropriate, they should retain control over personal data they have shared, also beyond the end of the project.

Recommendations for institutions

For universities, the recommendations are to:

1. Recognise citizen science as an evolving set of research methods, as well as its societal and educational benefits;
2. Consider creating, where viable, a single point of contact for citizen science within the institution, to advise scientists and ensure liaison with national and regional citizen science initiatives;
3. Raise awareness amongst researchers of criteria for successful citizen science, including community management, pedagogical practices, open science standards and social, intergenerational and gender diversity policies issues.
4. Ensure that proposals to granting bodies for citizen science projects include long-term commitment for infrastructures and data repositories, in line with other research projects with long-term scientific or societal benefits;
5. Ensure that project participants comply with ethical, legal and privacy regulations relevant to the scope of a given citizen science project, and have access to professional advice for this purpose;
6. Adapt research evaluation and reputation systems to include metrics that can characterise projects with a high societal impact, such as successful citizen science projects, and develop ways of assessing citizen participation.

Research funding organisations are encouraged to:

1. Recognise a wide range of success criteria when supporting citizen science projects, including but not limited to traditional measures of scientific quality;
2. When evaluating citizen science projects, ensure adequate funding for community management, platform development and other non-research functions characteristic of citizen science;
3. Promote the use of open science practices in citizen science projects, by requiring open access publication, open data standards, use of open source software, etc.;
4. Set clear legal and ethical criteria for data privacy according to existing laws, such as personal data control.

For policy making bodies the advice is to:

1. Commission independent studies to evaluate the reliability of citizen science and help ensure projects use evidence-based methodologies, recognised by scientific institutions;
2. Develop clear guidelines for legal, ethical, commercial and privacy issues that arise in citizen science, and encourage productive participation of citizens if possible.
3. Encourage long-term collaboration between research universities and non-governmental organisations to ensure that citizen science is sustainable.

Introduction

1. Amateur scientists have contributed to science for centuries, with significant discoveries in astronomy, archaeology, botany and other fields made by motivated individuals outside academic institutions (Bonney, 2014, p. 1436). But as the complexity and specialisation of science increased, the opportunities for citizens without professional credentials to participate actively in cutting-edge research have dwindled during the last century. In parallel, professional science communication has evolved so that research institutions now routinely broadcast new results to the public through various media and science events. Through these actions citizens learn about science, but do not actively participate in the scientific process.

2. Over the past couple of decades, however, the active participation of citizens in research has witnessed a revival (Wiggins, 2011). Nowadays, researchers at many LERU universities and elsewhere are actively involved in managing citizen science projects in various fields. A few examples in separate boxes throughout the paper illustrate the wide range of citizen science projects from different research fields and with different set-ups. The Appendix serves as a further resource with examples of citizen science projects at LERU universities.

3. The boundaries of what can rightly be termed citizen science are debatable, but there is broad consensus that projects should involve voluntary and active public engagement with research. Projects that cull public data from social media, exploit data gathered from medical cohorts, or incentivise participation without clearly stating the scientific purpose of the activity, are not normally considered to be citizen science, although they may have the potential to become it.

4. The reasons for the rise of citizen science are varied: an increasingly highly educated, well informed and active public is interested in and concerned about the environment, benefits and risks of technology or medical developments. Furthermore, scientists have discovered that citizen participation may expand the scope of the data gathered by research projects. Citizen participation may also strengthen the involvement of scientists and their institutions with the public. LERU's commitment to track important developments in research and to encourage a productive relationship between science and society motivates this paper.

5. The growth of citizen science has been enabled by the rise of new technologies such as the internet, the web, mobile phones and smartphones. Furthermore, open source software and hardware tools, digital fabrication technologies and online social network platforms and science 'kits' have contributed to broadening the spectrum of citizen science activities for the general public, as in the iSPEX project at Leiden University, where 3,000 citizens measured air pollution with their smartphones, thus providing novel data. LERU views this trend of technology-assisted citizen science as part of the wider open science movement, along with open access publishing, open data standards and alternative metrics for impact assessment, contributing to a novel science culture that some see as a new scientific revolution (Nielsen, 2011).

6. There is a great diversity of citizen science projects, from small grassroots community initiatives with little or no involvement of academic researchers to major scientific projects led by professional scientists at

Vlaams Darmflora Project (Flemish gut flora project) - KU Leuven

This public health project, carried out in collaboration with the Flemish institute for biotechnology (VIB), collects stool samples from at least 5,000 volunteers and analyses the DNA of the microbiomes of these volunteers. This is one of the world's largest scientific studies of gut bacteria and aims to discover the various relations between gut flora and health indicators, such as obesity. The active involvement of citizens goes methodically beyond usual clinical studies, since the project relies on a long-term committed community through various stages of the project, upheld with the help of social media and face-to-face exchange, which enables the development of further research questions.

http://www.vib.be/nl/mens-en-gezondheid/darmflora-project/Pages/default.aspx

top universities. There is also a wide range of research quality and of scientific impact in citizen science. Poorly designed or badly executed projects may not only waste the time of professional and amateur scientists, they can be damaging to the reputation of scientific institutions involved in them. This wide range underlines the need to formulate guidelines for citizen science projects at research universities. The present LERU paper addresses primarily such projects.

7. In the context of this paper, then, citizen science is viewed as an evolving set of research methods that enlarges the scope of academic research. The position articulated here is that citizen science should be encouraged in a proactive fashion, not to the detriment of conventional research methodologies but for the increased scope that this approach can bring to many scientific activities.

8. Specific areas where citizen science is proving to be powerful at LERU universities include:

   - Projects with large and varied data sets, for example in astronomy or biodiversity, when existing automated data analysis tools may not reveal aspects that humans can perceive.

   - Studies in which the data generated by individual citizens play a key role, for example in health-related studies, requiring citizens to regularly record their own biomarkers or behaviours.

   - Research that exploits low-cost sensors, smartphones and untapped computing power in laptops and other devices to aggregate volunteer sensor or computer networks.

   - Research that covers a large geographical area and requires distributed observations to provide evidence about the movement of a species, the development of a natural phenomenon, or the impact of a disease.

9. Additional benefits of citizen science for LERU and other universities, beyond standard metrics of academic productivity, include:

   - Contributing to the educational and societal mission of universities by encouraging people, in particular teachers and students, to become more interested and engaged in science through active participation in research projects.

   - Enhancing the engagement of universities with society by involving citizens more directly in research that may have significant impact on their environment.

   - Engaging with a wide range of stakeholders who can provide insights, suggestions and ideas to improve existing research activities.

   - Enabling new research questions to be asked, when non-anonymised data is provided by consenting citizen scientists in areas such as health and socio-economics.

10. There are also wider benefits since citizen science projects, conducted at LERU universities, may encourage the public to become more educated and involved in discussions of topics like responsible research and innovation (RRI) (Vayena/Tasioulas, 2015). In particular, this includes science education at all school levels. These are all important objectives for science policy in Europe and elsewhere. Last year EU Research Commissioner Carlos Moedas announced an "Open Science, Open Innovation, Open to the World" strategy.[1] During the Dutch Presidency of the EU in the first semester of 2016, citizen science was one of the priorities of the Amsterdam Call for Action on Open Science.[2] The European Commission specifically recommended to promote citizen science, to develop a model for evaluating citizen science projects and to allow research funders to provide specific incentives for 'collaborative science' including citizen science.[3] In fact, several LERU universities collaborate with government and educational institutions; the University of Helsinki has projects with the Finnish Museum of Natural History, Lund University citizen science projects have been selected by the government to deliver trends for the Swedish environmental objectives, and the University of Barcelona works with the city of Barcelona to refine citizen science practices.

11. While the power and utility of citizen science in certain areas of research is now well-established, and its contribution to the Open Science debate clearly

1 http://europa.eu/rapid/press-release_SPEECH-15-5243_en.htm; https://ec.europa.eu/research/foresight/pdf/knowledge_future_2050.pdf
2 https://ec.europa.eu/research/openscience/index.cfm
3 https://ec.europa.eu/research/openscience/pdf/draft_european_open_science_agenda.pdf#view=fit&pagemode=none

acknowledged, it is also important to recognise the limitations of this approach. Even though citizen science may involve the development of specific research methods, as happens regularly in any sub-domain of science, it certainly does not represent an exception to the scientific method, and so its results must always be judged by the standard criteria of scientific research. There are also important legal and ethical implications of greater public involvement in research, especially when moving beyond small generic tasks to greater intellectual contributions by amateurs, which need to be considered carefully to avoid public backlash and reputational damage. The heightened public awareness that citizen science projects may generate in the context of ethically challenging issues should be handled with great care, to ensure rational and civilised discussion does not become laden with emotional and destructive arguments, a particular challenge in this era of spontaneous and often anonymous dialogue on social networks. It is in this context of heightened interest in the policy implications of citizen science that LERU has developed this paper.

12. Despite well-documented benefits, there are some sceptical voices in academia concerning the usefulness and the applicability of public participation methodologies and the scientific quality of the output from citizen science projects. Indeed, depending on the research aim or scientific field, citizen science is not always an effective approach. However, where it is appropriate, LERU agrees with a growing body of literature that citizen science can improve the quality, increase the quantity and broaden the scope of research results. As in any area of science, there are some basic methodological procedures to ensure the accuracy and reproducibility of results. In the case of citizen science, the situation may be more complex, because, as noted in the Green Paper on citizen science produced for the European Commission, "a wide range of heterogeneous stakeholders with different motivations and objectives tend to challenge the fundamental mechanisms of scientific evaluation systems" (Socientize, 2013). As a federation of European research-intensive universities strongly committed to excellence and high impact in research, LERU is well positioned to reflect on such emerging developments and their impact on the future of academia.

13. This paper aims to support professional researchers who (wish to) engage with citizen science with guidelines based on established success criteria for launching and running citizen science projects. It also formulates recommendations for LERU and other universities, funding agencies and policy makers on how to support professional scientists engaging in citizen science. LERU considers such a set of criteria essential to make good use of citizen science and benefit from its potential, while avoiding pitfalls that research methods involving public participation may create for academic institutions. These recommendations can therefore contribute to the European Commission's Open Science agenda.

Trends in citizen science at LERU universities

14. This section provides an overview of how citizen science projects have evolved over the last decade internationally and in particular at LERU universities and partner institutions, emphasising three important trends.

Yes, I do! (Ja, ik wil!) - Utrecht University

"Ja, ik wil!" is a digitisation and transcription project in the field of history, initiated by the department of Economic and Social History at the University of Utrecht in cooperation with the Amsterdam City Archive and nearly 500 volunteers. Launched in 2014 and using the web sourcing platform *Vele Handen* (Many hands), the project gathered one fifth of the complete Amsterdam pre-marriage acts, in total consisting of approximately 500,000 records of 900,000 individuals who intended to get married in the period between 1578 and 1811. Registering a variety of information on couples-to-be over such a long period, these serial sources are unique for the early modern period. The project provides insight into early modern marriage practices and related socio-economic issues in protestant Amsterdam, including age at marriage, towns of origin, places of residence, occupations and parental relations. In February 2016 the project, which was part of a larger research project to be finalised in 2018, was completed; the massive database is currently being used by researchers from different subfields of history.

http://collective-action.info/_PRO_Ja-Ik-Wil_Main

15. In the early 2000s, citizen science projects were generally initiated by individual scientists or small groups, with some notable exceptions such as the field of archeology or the Cornell Lab of Ornithology, whose project ebird has played for decades a coordinating role for citizen science initiatives involving bird watchers.

16. A first important trend in the last ten years, involving also researchers from LERU universities, has been increased coordination and communication between scientists from different disciplines and institutions about the practice of citizen science.

17. Several technical gatherings have provided researchers with forums to discuss commonly used citizen science tools. Partnerships like the Citizen Science Alliance and the Citizen Cyberlab, both launched in 2009, have been created to promote the use of citizen science at research universities. The Citizen Cyberscience Summit at King's College London in 2010 and sequels organised by University College London in 2012 and 2014 represent some of the first dedicated meetings where up to several hundred researchers from a wide range of fields, using different citizen science platforms and methodologies, shared experiences with each other and with representative citizen scientists. As these examples indicate, LERU universities have actively participated in advancing the broader coordination and communication between researchers involved in citizen science.

18. In the last few years, several networks and associations have emerged that encourage and coordinate citizen science initiatives, at both national and regional levels, between a range of stakeholders. Significant international organisations of this type are the US-based Citizen Science Association (CSA) and the European Citizen Science Association (ECSA). National networks are also emerging, such as the Australian Citizen Science Association (ACSA), the Austrian '*Österreich forscht*' or the Citizen Science Network Switzerland. These associations and networks include research labs, LERU and other universities, museums, foundations, agencies, local community organisations and private individuals. They initiate journals, develop policies and organise major meetings and events. For example, the first conference of the Citizen Science Association, Citizen Science 2015, involved over 600 participants. Also in 2015, ECSA published its "10 principles for citizen science",[4] which it suggests underlie good citizen science practice. The relation of these projects to academia is varied. Further developments may lead to more systematic contacts and to fruitful collaborations.

19. A second important trend of citizen science, in which LERU universities have been actively involved, has been the emergence of crowdsourcing platforms that enable volunteers to contribute to different research projects, and transition easily between them.

20. A well-known example is Zooniverse, which has over a million registered users contributing to some 40 data classification projects, such as Galaxy Zoo from Oxford University, where volunteers classify automatically recorded images of galaxies. Another is BOINC, an open source platform for volunteer computing projects, which was developed at the University of California at Berkeley, and supports over 50 volunteer computing projects with a total of nearly 3.5 million registered users, one example of which is MalariaControl.net from the Swiss Tropical and Public Health Institute, where volunteers contribute spare computing capacity to carry out large-scale simulations of malaria epidemiology. On smartphones, open platforms like Epicollect, developed by scientists at Imperial College London and Open Data Kit from the University of Washington, are popular solutions for organising citizen scientists to gather data about various aspects of their environment. Open source hardware for science is also becoming more widely available, for example for low-cost do-it-yourself pollution and radiation monitors. Environmental data, such as the observation of bees as indicators of city environmental quality, is also a focus of the various projects of OpenSystems by the University of Barcelona. Crowd crafting, initiated by the University of Geneva and partners, is a web-based service that invites volunteers not only to contribute to crowdsourcing projects but also to develop their own, using a simple open source software platform. Finally, we mention FabLab-Leuven, '*Iedereen wetenschapper*' and ArchaeoHotspots, where members of the university and the public can initiate projects.

21. Not only do these platforms attract large user numbers, they also generate significant amounts of valuable research results that may not have been possible otherwise. Nearly 100 scientific manuscripts, mostly published in international journals, are based on data classified by participants on the Zooniverse platform. The projects supported by BOINC have helped pro-

4 http://ecsa.citizen-science.net/sites/ecsa.citizen- science.net/files/Ten%20principles%20of%20citizen%20science%20FINAL.pdf

duce roughly 200 refereed publications, including more than 10 in the top journals Nature and Science.

22. A third trend is that professional scientists at LERU and other universities are inviting citizens to play an increasingly sophisticated and central role in the citizen science projects they develop.

23. A prime example is Foldit, a game developed by researchers at the University of Washington, devoted to the long standing problem of protein folding. Foldit has attracted hundreds of thousands of players, amongst whom a few highly dedicated teams of citizen scientists have found significantly better solutions for folding certain proteins than elaborate computer simulations were able to do. This has led to the inclusion of such teams as co-authors on publications in *Nature*.

24. In aging research, for example, there is a growing tendency in the international literature to include older people not only as stakeholders, but also as research partners (Blair/Minkler, 2009). Involving citizens as participatory researchers in their own data leverages the value of non-anonymised data, sometimes collected for many years, thus allowing researchers to conduct studies retrospectively. Researchers at the Center for Gerontology at the University of Zurich have collaborated in this way with older adults and non-academic professionals since 1998 (Eicher et al., 2016). Similarly, Lund University has established CASE, a national centre for aging and supportive environments. At University College London, patients help design research studies and find new ways of describing pain.[5]

25. The Extreme Citizen Science (ExCiteS) group at University College London is also pushing the boundaries of participation by enabling public engagement in community-driven citizen science. The UCL group is providing a set of methodologies and tools for do-it-yourself citizen science to any user, regardless of background or literacy level, including residents in disadvantaged inner city neighbourhoods or hunter gatherer tribes in the Congolese rain forest.

26. Several LERU universities, among them Leiden, Lund and Zurich, are planning Citizen Science Labs with an apropriate infrastructure where projects can be initiated and carried out in a supportive environment and with high standards.

27. In the future, we anticipate the use of machine learning technologies and artificial intelligence to further extend the power of citizen science platforms, especially of those depending on human intelligence. These developments may lead to new and more demanding roles for citizens in citizen science projects.

28. We have outlined three trends: 1) coordination/communication between projects and interdisciplinary collaborations, 2) crowdsourcing platforms that support a variety of citizen science projects, and 3) initiatives that encourage more prominent roles for citizens. These trends reflect the increasingly diverse landscape of citizen science, which is further broadened by emerging national and international associations for citizen science. As a result of this evolution and growing diversity, citizen science has itself become a topic of research for historians and sociologists (Strasser/Edwards, forthcoming). On the basis of these trends, LERU is convinced that citizen science offers a unique opportunity to promote original and excellent science in various fields.

Zooniverse and Galaxy Zoo - University of Oxford

Zooniverse is a large, open platform for data analysis through distributed effort which started in 2007 with a single project, Galaxy Zoo. This first project demonstrated that volunteers inspired by the opportunity to contribute to science would make great efforts to help, and uncovered the potential for serendipitous discovery opened up by citizen scientists. For example, volunteers discovered an exciting ionised gas cloud around a distant galaxy named *Hanny's Voorwerp*. Zooniverse now supports projects in fields ranging from ecology to medical science, and datasets encompassing everything from particle tracks from the Large Hadron Collider to pictures of penguins in Antarctica. Researchers are able to use an online project builder to build, test and deploy their own projects, collaborating with the more than 1.5 million Zooniverse volunteers. Their collective effort has led to the publication of more than one hundred peer-reviewed papers, much effective outreach, and grant support in excess of £3 million.
https://www.galaxyzoo.org/

5 https://www.ucl.ac.uk/jro/patient-public-involvement/UCLH_UCL_patient_case_studies_web.pdf

Guidelines for scientists

29. As outlined in the previous section, citizen participation in scientific endeavours is rapidly increasing in scope. As a result, research projects that occur partially or wholly outside conventional academic settings may challenge the position of universities as the reference point for research, and raise questions about the quality of the results. In this situation it is important that research-intensive universities such as the LERU members move forward to develop and establish the methods and procedures that help ensure citizen science projects lead to reliable and reproducible results. While there are examples in the literature of specific guidelines for interface design or community building in citizen science, there is no established set of general guidelines for citizen science projects led by or involving university researchers. In this section, therefore, we present seven guidelines for researchers who wish to develop and run successful citizen science projects. These guidelines are each preceded by a preamble, which justifies them based on lessons learned from existing examples of successful citizen science projects. Elements of these guidelines were discussed and refined at a workshop entitled *Standards and Recommendations for Citizen Science*[6] held at the University of Zurich on 17 November 2015 and co-organised by LERU members University of Zurich and University of Geneva, in collaboration with ETH Zurich, and in which citizen science practitioners from a number of LERU members participated and contributed their views.

Guideline 1: Recruitment and retention

30. At the core of a citizen science project, there must be a sufficient number of motivated citizens. Successful platforms such as Zooniverse often recruit citizens via the internet, using conventional media, e.g. a press release, to raise initial awareness of a new project, and social media to leverage the enthusiasm of citizen scientists. Launching a new project this way may attract many thousands of new people to the project in a day. However, converting initial curiosity in a project into longer-term involvement is a challenging and labour-intensive task, which requires skills in human-computer interaction, science communication, and community facilitation. Indeed, a study of Zooniverse project statistics shows that most newcomers to the website of a project leave without having made any contribution, which is consistent with more general patterns of user attention on websites (Sauermann/Franzoni, 2014).

31. Even projects that are successful at recruitment and retention, such as some of the BOINC projects, may observe strong gender or age bias in their citizen science population, as well as a lack of diversity in the social background of those participating. While any bias can be detrimental to the value of the outcome,[7] diversity may be particularly crucial in certain citizen science projects, where the results depend on highly individualised opinions and experiences. Tackling the diversity issue is also important if the project is to contribute effectively to public outreach goals.

32. **Guideline 1:** When designing a citizen science project, researchers should plan for substantial and sustained investment in outreach and community management, to ensure adequate numbers and diversity in the citizen science community that will participate in the project.

Guideline 2: Quality and impact

33. A recurring concern voiced by scientists not familiar with citizen science is the quality of citizen science projects judged in terms of common scientific criteria. Concerning reproducibility, the large variability of citizen science data may need special attention, especially in cases where statistical validation by standard sampling techniques may not be an option. Concerning impact - usually judged by metrics such as publications - other aspects have to be considered. In keeping with emerging standards of open science, the quality and impact of a citizen science project should therefore be measured by a broader set of metrics, as advocated by the San Francisco Declaration on Research Assessment (DORA, 2012), which LERU signed. Impact should be measured in ways that are timely and concrete – such as data sets, progress reports and conference contributions – and consistent with general standards of academic research as well as best practice in the specific discipline(s) of the project.

34. In addition to these indicators, more popular communication, ranging from classical media coverage to blogposts and social network presence, should be encouraged to motivate public participation and used as further indicators of success. However, such dissemination should be done thoughtfully, as evidence from discussion forums in many citizen science projects points to a generally sophisticated

6 http://www.imsb.ethz.ch/news-and-events/events/citizenscienceworkshop.html
7 http://www.leru.org/files/publications/LERU_Paper_Women_universities_and_research.pdf

and discerning public audience. Therefore, vague and unrealistic statements about impact should be avoided in favour of realistic assessments of the significance of the research within its field. This measured approach to communication can contribute to a better public understanding of the laborious and incremental nature of most scientific progress. This includes proper citation of prior or competing work of which the researcher may be aware, avoiding wasteful or repetitive studies, and openly sharing information about changes to the research plan that may occur during a project.

35. **Guideline 2:** Researchers planning citizen science projects should clearly define the impact they aim to have at the outset of the project, as well as track and regularly communicate to the participants progress towards this impact, or deviations that may occur, through a broad range of indicators, from scientific publications to more popular forms of dissemination.

Guideline 3: Learning and creativity

36. Citizen science projects are often presented as a way for the public to learn more about science through active participation. But designing projects for an effective learning experience by a lay public requires pedagogical and presentational skills, as well as dedicated staff power. Developing adequate pedagogical content should be planned for when designing citizen science projects.

37. Many existing citizen science projects rely on message boards and forums for scientists to answer questions from participants. Opportunities for more creative contributions, such as discoveries, inventions or significant improvements to a project, often occur in an ad hoc way through these communication channels (Raddick et al., 2009). One example is the discovery of the astronomical object called *Hanny's Voorwerp* in the Galaxy Zoo project, by a Dutch schoolteacher, Hanny van Arkel. The breakthroughs in protein folding made by certain individuals and teams in the Foldit project are another example.

38. Since education is evidently a primary role of universities, it is important that informal learning opportunities are emphasised as part of the effort of designing a citizen science project. In the 'Yes, I do' project at Utrecht University, participants acquire in-depth knowledge of history-related fields such as paleography. Pathways for participants to advance their scientific skills, and ultimately contribute creatively to the scientific process, have been the focus of the recent EU-FP7 project Cyberlab, and should be encouraged wherever possible. At the University of Barcelona the impact of citizen science in schools is tested.

39. **Guideline 3:** Where feasible, projects should be designed to encourage all participants fully to contribute their talents and creativity, to grow their skills and responsibilities within the project, and to increase their knowledge of the related science in a pedagogically sound way.

Guideline 4: Openness and transparency

40. In agreement with recent EU policy, LERU regards citizen science as part of the open science movement, which includes initiatives such as open access publication, open source software and open data standards. In fact, citizen science projects can be greatly enhanced by open science practice. While individual researchers running citizen science projects sometimes do not adhere to all open science standards (for example in using proprietary software),

OpenSystems Research - Universitat de Barcelona

OpenSystems, founded in 2012, builds tailor-made research collectives to address concerns and issues mostly grounded in urban contexts. In 2014, OpenSystems founded the Barcelona Citizen Science Office in collaboration with the city council to keep a direct relation with citizens. The Office now hosts more than 20 projects belonging to several universities and research centres. OpenSystems also co-designs collective and pop-up experiments with citizens to respond to societal challenges and publicly discusses their results. Experimental setups are placed 'in the wild' with situated experiments involving citizens at different levels on topics, such as urban bees, climate action, mental health, human mobility or cooperation. Public experiments, some of them with schools and festivals, have engaged more than 6,000 participants and over 20 institutions or organisations. Results have been published in journals such as Science Advances or Nature Communications.

http://www.ub.edu/opensystems

they should be encouraged to do so and should be supported by their institutions in adopting open science standards. Greater transparency in citizen science projects increases public trust, with potential positive effects on recruitment and retention. It also anticipates a general trend amongst funding agencies and foundations to support open science.

41. Transparency about the research objectives, research protocol and analysis techniques are important issues for researchers to consider, in order to ensure the trust of participating citizens and to fully document the quality and reproducibility of results. There may be exceptions, in particular when dealing with data privacy issues, such as when patient medical data is involved, or when the participants are sharing personal data as part of a project, as discussed in the section on legal and ethical issues below.

42. **Guideline 4:** Researchers developing citizen science projects should adopt open science standards consistent with their institutional policies, including open access publication, open data standards, open source software, and extending to full transparency of research methods.

Guideline 5: Organisation, communication and sustainability

43. Especially for larger and more complex projects, governance issues are important for success. For example, health science projects, which involve many stakeholders including health services providers, require steering groups and may necessitate ethical reviews. In some cases, a dedicated community manager may work with the research group to decide about criteria for participants and how to communicate the overall research agenda to the participants. Scientists should inform themselves about best practice in citizen science projects relevant to their area of research, before deciding on research design specifics and procedures. At UCL, the course *Designing Citizen Science for Multiple Knowledges* introduces and describes successful citizen science.[8]

44. Online forums, blogs by the scientists, periodic electronic chats and face-to-face video discussions using platforms, such as skype, are widely used to allow citizen scientists to ask questions and voice concerns about a project. These electronic communication platforms should be organised so as to avoid negative phenomena, such as online harassment (trolling), by enforcing clear codes of conduct between participants. In order to learn more about best practices and avoid known pitfalls, scientists may consult with the emerging citizen science associations.

45. Long-term sustainability is particularly important for citizen science projects which have long-term goals, such as those tracking environmental changes over many years. The stability of project manpower and support is one important aspect for which all stakeholders in citizen science projects initiated at research universities, including the scientists, university management and funding organisations, need to plan carefully.

46. **Guideline 5**: Citizen science projects require appropriate organisational and oversight structures to represent the interests of all stakeholders, codes of conduct to ensure respectful communication between all participants, and a long-term data preservation plan that enables open access to results and data, ideally sustainable beyond the end of the project.

Guideline 6: Credit and rewards

47. Properly acknowledging the contributions of the citizens requires some balance; there are many options depending on the level and intensity of citizen participation. Participants may be sent letters of recognition for their contributions or invited to participate in meetings involving the scientists; often personal acknowledgements may take the form of a website listing the names of the participating citizen scientists, as well as specific acknowledgements in press releases and related press coverage. In all these cases, permission should be sought before releasing names or private information about participating citizen scientists.

48. In many citizen science projects, citizen participation is acknowledged in scientific publications that are based on the data produced by the citizens. In certain projects where the significance of citizen contributions is deemed to satisfy standards for co-authorship an individual or a team may be credited as co-author. In such cases, citizens should be consulted, in keeping with academic standards, on the draft article and should provide written consent to be named as co-authors. Another form of acknowledgement is the naming of objects, such as comets or plant varieties, after the discoverer. Again, where this is an option, consent should be obtained

8 https://www.ucl.ac.uk/basc/current/core/ie/basc2096

before any announcement is made. Another alternative is to include the citizens in the internal and external communications issued by a project.

49. Another class of incentives that is used in many citizen science projects consists of points or other measures of contribution that enable a ranking of individuals or teams. Such gamification is widespread in citizen science, and can become a primary motivation for participation for an often very loyal and productive part of the community who may otherwise show limited interest in the science itself. However, a clear distinction should be made between projects with a gamification element and projects where the credit system involves monetary rewards and the role of the participant shifts from volunteer to paid worker (e.g. Amazon Mechanical Turk). While projects based on this commercial form of crowdsourcing may produce perfectly valid scientific results, they are not normally considered to constitute citizen science.

50. **Guideline 6:** Citizen participation should be recognised properly, for example through acknowledgement or co-authorship in publications where appropriate, through motivational rewards and through a credit system that enables tracking of contributions.

Guideline 7: Ethical and legal considerations

51. The involvement of citizens in research projects raises new ethical issues concerning the interactions between citizens and academics. Both professional scientists and citizen scientists have certain rights and obligations in a citizen science project. These rights and obligations may include issues such as ownership of data gathered or analysed by citizen scientists and intellectual property produced in a given project. A written code of conduct should ensure that all parties are aware of their rights and obligations from the outset of the project and should define appropriate procedures to handle disputes. The legal status of participants in citizen science projects and of the data and knowledge they generate may require special attention. Another ethical and legal dimension concerns the assessment of physical, psychological and privacy risks for citizen scientists, especially where self-experimentation takes place. Many existing projects require participants to agree to standard terms and conditions, which may be suitable for new projects of a similar type. However, if in doubt, researchers are encouraged to seek legal advice.

52. A broader ethical issue is the balance between encouraging greater public participation in the research process, which is a frequently used justification for citizen science projects, and the optimal use of the resources that citizen scientists provide, which is a strong motivation for individual researchers to adopt this approach. A consent-based approach is suggested so that, where relevant, researchers may introduce ways for citizen scientists to participate in the operational phases of a research project, e.g. in its design, the interpretation of results and publication of findings. Particular care applies to health-related research where the citizens may be researchers and test persons at the same time and may share personal health-related data collected before the start of a study. In this situation, adequate 'informed consent' procedures should be provided to ensure that citizens retain control over how their own data is used by scientists, also beyond the end of a project.

53. **Guideline 7:** Researchers should provide clear terms and conditions to participating citizen scientists consistent with both open science and personal privacy requirements. Where useful to the project, citizens may be involved in decision making aspects. Where appropriate, they should retain control over personal data they have shared, also beyond the end of the project.

Centre for Ageing and Supportive Environments (CASE) - Lund University

CASE is an interdisciplinary National Centre of Excellence for research on ageing with user participation. Activities focus on older people at the individual, group, and population levels and on environments that support activity, participation and health. Knowledge users (such as public agencies, industry) are involved in the research and in the knowledge translation processes. The centre implicitly contributes to developing methodologies relevant to citizen science projects. An exemplary project was the development of an ICT application for user-driven housing provision engaging senior citizens in Sweden, Latvia, Germany and Italy.

http://www.med.lu.se/english/case

Recommendations for institutions

54. As argued in the introduction of this paper, citizen science has the potential for further developing the scope of public involvement in science. As a consequence it is high on the European research agenda. In the previous section we have developed a set of seven guidelines to assist individual researchers in achieving excellence in citizen science. In order to realise such projects the support, guidance and oversight of a range of institutional stakeholders is required. In this section, after briefly reviewing the status of institutional support for citizen science and associated assessment criteria, we provide a list of recommendations for three major stakeholders in citizen science projects: research universities; public and private funding organisations; and policy-making bodies. These recommendations are intended to help institutions include citizen science in an effective way in their strategic planning, and ensure that projects are funded and assessed in a manner that is consistent with the resources that citizen science projects need to succeed, as identified in the guidelines presented above.

55. Over the years, guidelines and procedures have been developed for academic research in order to enable competitive evaluation, allocate funding, ensure compliance with ethical and diversity rules and respect the public interest. In view of its research potential, citizen science should be considered where it may lead to better results. Thus it could be embedded into existing funding schemes by requiring correspondingly high standards.

56. However, citizen science projects are generally complex and often interdisciplinary, so their assessment can be quite difficult. Additional procedures complementing standard academic criteria may be necessary to ensure both the high quality of a project as well as other benefits in such public engagement. For instance, general-purpose platforms, often an integral part of citizen science projects, are not consistent with the requirements for more narrowly specified novelty and excellence criteria expected in most publicly funded science. Indeed, some large citizen science platforms such as Zooniverse receive a large fraction of their support from private donors.

57. The European Environment Agency (EEA) has pioneered many citizen science projects on biodiversity monitoring and also the EU seventh framework programme (FP7) funded numerous citizen science activities in areas such as informal learning. In the USA the National Science Foundation funds citizen science projects with grants for education and the Obama administration has developed a toolkit for citizen science.[9] Research funding agencies indirectly support some citizen science activities by asking for 'project-related science outreach'. The EC encourages citizen science projects as part of its 'Open Science' and 'Responsible Research and Innovation' policies under the 'Science with and for Society'[10] theme of the current EU framework funding programme Horizon 2020. As already mentioned in the introduction, the European Commission, in promoting an open science environment in Europe, explicitly supports citizen science. Given that LERU represents some of the principal institutions involved in implementing this open science agenda in Europe, it is well suited to provide institutional guidance for the development of citizen science.

58. In Europe, many examples of citizen science strategies exist at the national level, too. In the UK, citizen science is integrated in the national strategy for tree health and invasive species.[11] In Germany, the Ministry of Education and Research (BMBF) supports the citizen science platform *Buergerschaffenwissen*, which brings together many initiatives and plans its own Citizen Science Strategy 2020. In Austria, the Sparkling Science programme, which started in 2007, has involved scientists working alongside young people in over 250 scientific research projects.

59. Regionally, the Scottish Environmental Protection Agency (SEPA) has made a strong commitment to citizen science and is part of the UK Environmental Observation Framework. At the city level, the Barcelona Citizen Science Office is an initiative of the City Council to promote a model of cultural innovation. In many of these initiatives, scientists from research universities are closely involved. And in certain areas where citizen participation is seen as strategic, targeted funding for citizen science projects has been allocated. For example, the Medical Research Council (MRC) in the UK supports the public engagement of researchers.[12]

9 https://www.whitehouse.gov/blog/2014/12/02/designing-citizen-science-and-crowdsourcing-toolkit-federal-government
10 https://ec.europa.eu/programmes/horizon2020/en/h2020-section/science-and-society
11 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/307355/pb14168-plant-health-strategy.pdf
12 http://www.mrc.ac.uk/research/public-engagement/

60. Nevertheless, alternative donors remain crucial. In the UK, the Open Air Laboratories have conducted a ten-year citizen science project, supported by the national lottery and private funders such as the Wellcome Trust. It was such support that led to the creation of ECSA, the European Citizen Science Association. In Japan, the Takagi Foundation, established in 2001, provides research and training grants of up to USD 5,000 to citizens or organisations engaging in citizen science.

61. These examples suggest that when funding schemes and programmes that are appropriate for citizen science projects are created, the quality and impact measures used by such programmes are judged on a wide range of significant criteria, consistent with the guidelines for citizen science projects presented in the previous section. These considerations lead us to the following three sets of recommendations.

Recommendations for LERU universities and other research performing organisations

62. LERU universities and other research performing organisations are encouraged to:

- Recognise citizen science as a valid and rapidly evolving set of research methods, as well as its societal and educational benefits.
- Where it is viable for an institution, consider creating a single and visible point of contact for citizen science within the institution, to advise and support scientists and ensure liaison with national and regional citizen science associations. The person may be an existing member of the university communications team, for example.
- Raise awareness amongst researchers of criteria for successful citizen science, including community management, pedagogical explanations, open science standards and social diversity by appropriate measures such as courses in citizen science.
- Ensure that proposals to granting bodies for citizen science projects include long-term commitment for infrastructures and data repositories analogous to many research projects with long-term scientific or societal benefits.
- Ensure that project participants comply with ethical, legal and privacy regulations relevant to the scope of a given citizen science project, and have access to professional advice for this purpose.
- Add to standard research evaluation and reputation systems metrics that characterise successful citizen science projects in terms of quantifiable measures of citizen participation.

Recommendations for research funding organisations

63. There is a plethora of funding institutions in Europe and beyond, each with their own objectives and quality criteria. However, some recommendations which should apply to most of them are:

- Recognise and encourage a wide range of success criteria when supporting citizen science projects, including but not limited to traditional measures of scientific quality.
- When evaluating citizen science projects, ensure adequate funding for community management, platform development and other non-research functions characteristic of citizen science.
- Promote the use of open science practices in citizen science projects, by requiring open access publication, open data standards, and the use of open source software.
- Set clear legal and ethical criteria for data privacy according to existing laws, such as the control of personal data.

Extreme Citizen Science (ExCiteS) - University College London

Extreme Citizen Science, ExCiteS, is a bottom-up initiative at UCL that allows citizens to design and build new devices and start knowledge creation processes with a broad network of people including university experts. With an interdisciplinary research approach ExCiteS aims to provide any user, regardless of her or his background or literacy level, with a set of tools that can be used to collect, analyse and act on information according to agreed scientific methods. ExCiteS makes use of the innovative IT platform Sapelli, which allows citizens to engage in research with little or no prior ICT experience. Equally, ExCiteS makes use of GeoKey, a platform for participatory mapping. ExCiteS has led to a sizeable number of publications and theses, and has secured over €7,500,000 in research grants from EU FP7, H2020, and the UK EPSRC, ESRC and AHRC over the past five years.

https://www.ucl.ac.uk/excites

Recommendations for policy-making bodies

64. Policy-making bodies, often connected with governments at local, regional, national or supranational levels, can play an important role in promoting citizen science projects. In view of the guidelines put forward in this paper, such bodies are recommended to:
    - Recognise and foster scientifically valid and ethically sound citizen science and raise awareness of citizen science in the public arena, through appropriate policies.
    - Commission independent studies to evaluate the reliability of citizen science and help ensure projects use evidence-based methodologies recognised by scientific institutions.
    - Develop clear guidelines for legal, ethical, commercial and privacy issues that arise in citizen science, and encourage productive participation of citizens if possible.
    - Encourage long-term collaboration between research universities and non-governmental organisations to ensure that citizen science is sustainable.

Concluding remarks

65. In conclusion, the guidelines and recommendations presented in this LERU paper address citizen science projects that are developed and maintained by professional scientists at LERU and other universities. The guidelines are neither exhaustive nor comprehensive. They provide actionable advice based on experience from existing citizen science projects, and are based on recent trends in the organisation of citizen science. Since citizen science involves a rapidly evolving set of research methods, best practice should be continuously re-assessed in light of technological advances and societal change.

66. By being part of the production of scientific knowledge, citizens may feel encouraged to be actively and responsibly involved in the ways in which knowledge and expertise enter (public) policy making, in the endeavour to develop evidence-informed public policy. We thus hope that this LERU paper will prove to be useful to EU policy making, notably by advancing the European Commission's 'Open Science, Open Innovation, Open to the World' strategy and the Responsible Research and Innovation (RRI) policy, and by supporting the actions that are currently being developed in this area.

Climate change impacts on earthworms in Finland - University of Helsinki

This project investigates the potential effects of climate change on earthworms in Finland, and the implications for above-ground/below-ground interactions. After preliminary surveys, a citizen science project was set up to collect large amounts of data. These data will be used to create models to predict future distributions of earthworms in Finland in response to climate change. This project is one among several of the University of Helsinki's Global Change and Conservation (GCC) research groups. GCC is an interdisciplinary research group that promotes academic research and postgraduate education in conservation science and has led to a large number of publications.

http://h149.it.helsinki.fi/research/projects/

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Appendix

Citizen science initiatives at LERU universities and beyond

The projects below showcase citizen science research performed at LERU universities and beyond. While the wide spectrum of topics, projects, objectives, platforms, etc. included here highlights the many dimensions of citizen science, the selection is far from exhaustive.

For each project, we have included a project summary, a universal citizen science platform (web portal) if applicable, research partners and the project website. To situate the projects in the wide landscape of citizen science, we denote them by three taxonomic criteria:

- **Scientific problem**: refers to the scientific discipline(s) involved in the project. As the examples show, there is a wide variety of disciplines engaged with citizen science.
- **Type of technological solution**: We distinguish between volunteer sensing, where participants gather data, often using devices such as smartphones, volunteer thinking involving some action on data, such as classification or digitisation, and volunteer computing, where participants share the processing power of their own phones and computers. These activities may overlap within a single project. For example, health projects often involve both gathering one's own data (distinct from clinical studies where subjects' data are collected by professionals) and analysing it together with scientists.
- **Level of volunteer contribution**: The role of volunteers may range from micro-tasking, implying that the participants are asked to answer relatively simple and repetitive questions, to problem solving, engaging participants in solving problems, which may require significant skill, knowledge or insight, and original research, encouraging collaboration between participants and scientists on defining problems and approaches, such as the scope and methodology of a research project.

Citizen science projects are often interdisciplinary and involve volunteers in a variety of activities. Thus, the taxonomy suggested above is only a rough guide to project contents.

Moreover, citizen science at universities covers more than just projects. Some LERU universities are or will be setting up citizen science laboratories or centres, aiming to support citizen science projects for all disciplines. They form a visible entry point for citizens and ensure maintenance and developments of the guidelines proposed in this paper.

For example:
Lund University (Department of Astronomy) together with Vattenhallen Science Center (http://www.vattenhallen.lth.se/english/about/) has advanced plans for a citizen science centre. Both the University of Zurich and Leiden University are in the process of setting up multi-disciplinary Citizen Science Labs to attract researchers to engage in novel citizen science projects. Citizen Cyberlab (which grew out of an EU-funded FP7 project) is a partnership between the University of Geneva, CERN and the UN Institute for Training and Research, to develop and study new forms of public participation in research, to encourage citizens and scientists to collaborate in new ways to solve big challenges.

Urban bees - Universitat de Barcelona

This project uses urban bees as indicators of environmental quality of a city, through open source sensors installed outside and inside urban beehives. It involves environmental scientists, physicists, technologists and artists as well as citizens.

Taxonomy: environmental studies / volunteer sensing / problem solving
Platform: Open Systems, http://www.ub.edu/opensystems/
Partners: Natural Sciences Museum Barcelona, European Project "Socientize"
Website: http://openbeeresearch.org; http://www.ub.edu/opensystems

Bee-Path - Universitat de Barcelona

Bee-Path is a tool to study human mobility through its record by a mobile devices application. It proposes mathematical models to explain the observed phenomena, so that, in the future, mobility in certain contexts could be predicted.

Taxonomy: Mathematics, IT / urban planning / volunteer sensing / problem solving
Platform: OpenSystems, http://www.ub.edu/opensystems/
Partners: City of Barcelona, Barcelona Science Festival
Website: http://bee-path.net

Human Behaviour and Games - Universitat de Barcelona

The aim is to investigate the rational behaviour of each individual in relation to his/her own benefit and to the collective benefit. Extensive use is made by computer games and social dilemmas. The project is based on a model of conflicts that has been studied in detail to model, analyse and/or solve many real world situations.

Taxonomy: psychology / economics / use-oriented / volunteer sensing / problem solving
Platform: OpenSystems, http://www.ub.edu/opensystems/
Partners: City of Barcelona, DAU Barcelona - Board Game Festival, Catalan Mental Health Federation
Website: http://www.ub.edu/opensystems/projectes/human-behaviour/

RIU.net - Universitat de Barcelona

RIU.net aims at understanding river ecosystems by simple observations of some key characteristics. The data collected can be used for planning decisions by communities. A related project is Flood-Up (https://larambla.ub.edu/flood-up/), which includes floods and heavy precipitations. The University of Barcelona also collaborates with city organisations and private donors like "La Caixa". See www.barcelonalab.cat/.

Taxonomy: water quality / climate research / environmental studies / use-oriented / volunteer sensing
Platform: Freshwater Ecology and Management (F.E.M.), http://www.ub.edu/fem/index.php/es?view=featured
Partners: City of Barcelona
Website: http://riunet.net

STEMForYouth - Universitat de Barcelona

This Horizon 2020 project aims to promote STEM education by scientific challenges. STEM4you(th) attracts young people to science and technology. Important aspects, such as collective decision making, responsible research and innovation are introduced in the educational context. Together with schools from the Barcelona area, a citizen science toolkit shall be developed.

Taxonomy: STEM education / volunteer sensing / problem solving / city planning
Platform: OpenSystems from University of Barcelona, http://www.ub.edu/opensystems
Partners: Several schools from Barcelona
Website: http://www.stemforyouth.eu/

Back on Track: *Kreuzbandriss-Studie* - University of Freiburg

The Department of Orthopedics and Traumatology at the University Hospital Freiburg is the first university institution in Germany to collect data on the medical care of patients using a smartphone application. With the mobile application patients can collect a variety of information on the healing process and the ability to practice sports after a cruciate ligament injury. On the basis of the data optimised medical care strategies will be developed.

Taxonomy: medicine
Website: https://www.uniklinik-freiburg.de/nc/presse/pressemitteilungen/detailansicht/presse/505/

Störung|Ha-fra-ah - University of Freiburg

The German-Israeli project "*Störung|Hafraah*", initiated by the Cluster of Excellence "BrainLinks–BrainTools" of the University of Freiburg and Theater Freiburg, tries to better understand the specific movement disorders related to Parkinson's disease. The project integrates three different perspectives: neuroscientific approaches, dancers' expertise on movement and patients' experiences. Conjointly, scientists, people with Parkinson's disease and dancers explored for a period of one year the different facets of human movement and what it means to lose control over it.

Taxonomy: neurosciences, arts, philosophy
Website: https://hafraah.wordpress.com/

Luomus Participate - University of Helsinki

This is a national citizen science study monitoring a wide range of animals and plants, including birds, rabbits, amphibians, butterflies and vascular plants.

Taxonomy: environmental studies / biology
Partners: Luomus, Finnish Museum of Natural History
Website: https://www.luomus.fi/en/participate

rOpen Gov - University of Helsinki

rOpenGov is a loose community of R package developers working on open government data, computational social sciences and digital humanities.

Taxonomy: computational social sciences / digital humanities
Partners: independent researchers
Website: http://ropengov.github.io/

Public excavations in Inari, Finnish Lapland - University of Helsinki

This project seeks to understand the diverse cultural values and meanings of the material heritage associated with the German military presence in northern Finland (Lapland) during WWII. The citizens are invited to join the excavations.

Website: http://blogs.helsinki.fi/lapland-dark-heritage/projektista-about-the-project/; https://www.helsinki.fi/en/news/public-excavations-in-inari-finnish-lapland

iSPEX - Universiteit Leiden

The iSPEX project led by Universiteit Leiden collaborated with more than 3,000 citizen scientists throughout the Netherlands, who in 2013 provided measurements of air pollution with their smartphone and the dedicated iSPEX add-on and app.

Taxonomy: environmental studies / volunteer sensing / microtasking
Website: http://ispex-eu.org/

NEXUS 1492 - EU-funded project with Universiteit Leiden and others

This is a community archaeology project, involving participation of local indigenous people in Meso-America and the Caribbean to understand cultural phenomena in these regions.

Taxonomy: archaeology / volunteer sensing / problem solving
Website: http://www.nexus1492.eu

DNA and genealogy - KU Leuven

This project aims to study the genetic differences between regions through analyses of DNA and to understand the genetic differences between relatives.

Taxonomy: biology / genetics
Partners: Familiekunde Vlaanderen
Website: http://www.dna-benelux.eu/, http://bio.kuleuven.be/eeb/cor-project/degenialestamboom

The Mullard Space Laboratory - University College London

The data collected by missions is available to the general public – usually around 6-12 months after being received on Earth. These data are placed in NASA Planetary Data System and the ESA Planetary Science Archive. Examples of publicly available data are images, wind measurements, magnetic field measurements, particle measurements, and

radio emissions. Also included is professional work in collaboration with amateur astronomers.
Taxonomy: astrophysics / volunteer sensing / original research/ participatory
Website: http://www.ucl.ac.uk/mssl

Comprehensive Biomedical Research Centre - University College London
This unit of UCL and the University College London hospitals promotes the involvement of patients in biomedical research. It brings together patients and researchers to discuss open questions of both. Studies and research are then designed to meet the needs and interest of patients and researchers. This has led to several innovative developments, such as new ways of describing pain, the sustained establishment of HIV archives needed for further research and interactive websites for people with brain injuries.
Taxonomy: health / volunteer sensing / original research / strongly participatory
Website: https://www.ucl.ac.uk/jro/patient-public-involvement/UCLH_UCL_patient_case_studies_web.pdf

Extreme Citizen Science (ExCiteS) - University College London
The research group is dedicated to theories, methodologies, and practice of citizen science and bottom-up scientific practices.
Taxonomy: environment / community engagement / participatory
Platform: Sapelli, GeoKey
Partners: NGOs in the area of indigenous knowledge, community groups, research groups
Website: http://www.ucl.ac.uk/excites

Doing it Together Science (DITOs) - EU-funded project at University College London, University of Geneva and others
DITOs promotes the development of pan-European citizen engagement with science through citizen science, exhibitions and discussions.
Taxonomy: environment / biotechnology / synthetic biology / museums
Partners: 11 partners from UK, Spain, France, Germany, Poland, the Netherlands, Slovenia, Austria, Belgium, and the UK, from SMEs, NGOs, natural history museums and universities
Website: http://togetherscience.eu/

Transcribe Bentham - University College London
This is a digital humanities project, which transcribes the writings of philosopher and UCL founder Jeremy Bentham.
Taxonomy: Philosophy / digital humanities / crowdsourcing and participatory
Platform: Transcribe Bentham
Website: http://blogs.ucl.ac.uk/transcribe-bentham/

Svensk Fågeltaxering - Lund University
This is a national biodiversity monitoring project, tracing birds, currently with about 1,000 participants.
Taxonomy: environmental studies / biology
Partners: Swedish Environmental Protection Agency, County Administrative Boards, SoFBirdLife, European Bird Census Council
Website: http://www.fageltaxering.lu.se/english

The Swedish Butterfly Monitoring Scheme (*Svensk Dagfjärilsövervakning*) - Lund University
This is a volunteer-based, nationwide butterfly-monitoring project started in 2010, currently with more than 300 participants. Quality-controlled citizen science data from the project are included as indicators in the Swedish environmental objectives.
Taxonomy: biology / biodiversity monitoring / environmental studies
Partners: Swedish Environmental Protection Agency, Swedish Transport Administration, Swedish Board of Agriculture, County Administrative Boards, Swedish Entomological Society, Butterfly Conservation Europe, European Environment Agency
Website: http://www.dagfjarilar.lu.se/english

Centre for evidence-based psychosocial interventions (CEPI) - Lund University

The main mission of CEPI, a Swedish National Centre, is to initiate and carry out research in the field of psychosocial interventions and life situation in the community for people with a severe mental illness. Among the aims is to have a user orientation in research and implementation issues.

Taxonomy: Social psychology
Partners: Swedish government, Swedish Board of Health and Welfare
Website: http://www.med.lu.se/hv/cepi/om_cepi/cepi_in_english

Centre for Rehabilitation Engineering and Design (Certec) - Lund University

Certec undertakes research and education on rehabilitation engineering and design. The overall purpose is to achieve better opportunities for people with disabilities. For this, Certec engages technology, design concepts and participatory methods and develops ways to work in close partnership with people with disabilities. From the individual's situation and perspective, the goal is to find an optimal individual combination of technological and human assistance in everyday life.

Taxonomy: rehabilitation engineering / design
Partners: Interdisciplinary collaboration within the University (Department of Design Sciences, Faculty of Engineering)
Website: http://www.certec.lth.se/english

ClimatePrediction.net - University of Oxford

This project includes large-scale simulation of various climate models, seeking to answer questions on climate change.

Taxonomy: physics / climate research / micro-tasking
Platform: BOINC
Partners: Institutes and universities all over the world
Website: http://www.climateprediction.net/

Galaxy Zoo - University of Oxford

This project is about classifying images of galaxies collected from large-scale automatic surveys such as the Sloan Digital Sky Survey. The goal is to deduce from the visible appearance of many galaxies the mechanisms that govern the formation of galaxies.

Taxonomy: astrophysics / volunteer thinking / micro-tasking
Platform: Zooniverse
Partners: Many universities in Europe and the USA
Website: https://www.galaxyzoo.org

ArchaeoHotspots - Utrecht University

Citizen participation in archaeology has been promoted in the Netherlands since 2014 by regional ArcheoHotspots. One of these is established at the University Museum. Here professional archaeologists and trained volunteers supervise lab research performed by visitors and record and offer advice about archaeological finds. Results are integrated into existing regional and national archaeology databases.

Taxonomy: archaeology / volunteer sensing and thinking
Partners: AWN Vereniging voor Vrijwilligers in de Archeologie, Landschap Erfgoed Utrecht
Website: http://www.archeohotspots.nl/archeohotspots/archeohotspot-utrecht/

Healthy Aging Project - University of Zurich

This project's aim is to analyse and improve aging people's quality of life. It invites older people and relatives to actively participate in detecting major problems of aging and work towards their solution.

Taxonomy: gerontology / volunteer sensing / original research / participatory
Website: http://www.dynage.uzh.ch/index_en.html

LERU publications

LERU publishes its views on research and higher education in several types of publications, including position papers, advice papers, briefing papers and notes.

Advice papers provide targeted, practical and detailed analyses of research and higher education matters. They anticipate developing or respond to ongoing issues of concern across a broad area of policy matters or research topics. Advice papers usually provide concrete recommendations for action to certain stakeholders at European, national or other levels.

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