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Terms, definitions and abbreviated terms

List of project participants

Participant organisation name	Country
Polytechnic Institute of Setúbal (IPS)	PT
St. Pölten University of Applied Sciences (STPUAS)	AT
Hungarian University of Agriculture and Life Sciences (MATE)	HU
Politehnica University of Timisoara (UPT)	RO
University Colleges Leuven Limburg (UCLL)	BE
Vidzeme University of Applied Sciences (ViA)	LV

Abbreviated terms

E³UDRES² – Engaged European Entrepreneurial University as Driver for European Smart and Sustainable Regions

ExCites – Extreme Citizen Science

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Executive Summary

This guide aims to give practical guidance on the engagement of citizens and researchers involved in Citizen Science through projects, hackathons and I Living Labs organized by the E³UDRES² consortium.

Citizen science is a collaborative approach to research, involving individuals in various aspects of scientific inquiry, from data collection to analysis. Different engagement models, such as contributory and co-created projects, empower citizens and stakeholders to participate in different stages of the research process. The critical step of defining target groups ensures inclusivity and diversity, enhancing inclusivity in the research project. Tailoring projects to accommodate diverse engagement levels, from entry-level activities for beginners to leadership roles, fosters an inclusive citizen science community. Engagement methods, drawn from literature insights and Delphi rounds for which each partner institution drew inspiration from three case studies, provide structured approaches to involve the public effectively. The outcomes of citizen science extend beyond data collection, encompassing the creation of new knowledge, community building, and enhanced scientific literacy. Identification of barriers, guided by real-world podcasts from citizen science experts (two case studies from each partner institution), informs best practices for successful citizen science initiatives. In conclusion, citizen science emerges as a transformative force, shaping the future of collaborative research and community involvement, fostering a dynamic and inclusive scientific landscape.

This guide is part of the work package WP5 of Ent-r-e-novators, the task T5.1 with the following objectives:

- Collect how citizens are engaged in E³UDRES² alliance projects to evaluate their perception and expectations for citizen science projects: create a good practice format to start with (five cases per partner).
- Create podcasts about the perceptions and expectations of the engagement from the perspectives of all participants to ascertain the depth of and difficulties related with the involvement of citizens in their ongoing projects; how they picture their evolution in the future; in which areas/types of projects they see more possibilities for citizen science; which tools and resources they consider should be provided to citizens to collaborate in these projects.
- Literature study to collect policy documents and models of engagement outside the E³UDRES² consortium.

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- Through Delphi rounds, create new possible engagement models with researchers, educators, entrepreneurs and community builders.

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1 What is citizen science?

For a common understanding of citizen science, we provide a definition and short overview of citizen science and related research fields.

1.1. Definition and core principles

According to Vohland and colleagues (2021) citizen science broadly refers to the active engagement of the general public in scientific research tasks". Although this definition is broad, it clearly reflects the core principles of citizen science, namely public participation, collaboration, and the pursuit of scientific knowledge. The term citizen science originates from the 1990s (Vohland et al., 2021). From the very first citizen science study in the 1990s, generating scientific data, addressing political issues and engaging volunteers were clearly engrained in citizen science (Haklay et al., 2021). Despite consensus among researchers on these core aspects of citizen science, agreeing on one definition about citizen science is no easy task. Haklay and colleagues (2021) provide an overview of different citizen science definitions. Although there is a common pattern across definitions in mentioning the general public participation in scientific research, most definitions of citizen science are vague and leave room for discussion. Given the different fields, purposes and approaches that citizen science has been applied to, providing a clear unifying definition remains a challenge. This is in line with the claim of the European Citizen Science Association (ECSA, 2015) that citizen science is a concept which is flexible and adaptable to diverse situations and disciplines. In order to give more practical guidance on what does and does not qualify as a citizen science project, the ECSA (2015) defined the following principles of citizen science:

1. Citizen science projects actively involve citizens in scientific endeavours that generate 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.

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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 is 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 (ECSA, 2015, p. 1).

Again, the core principles of public participation, collaboration, and the pursuit of scientific knowledge are quite clear throughout these ten principles. Apart from citizen science, other research fields exist for which active participation of citizens, communities and stakeholders is one of the core principles. *Table 1* gives an overview of these research fields and key articles for the reader who wants to know more about different participatory research fields.

Table 1: Research fields whit active participation of citizens, communities and stakeholders

Research field	Reference
Amateur Science refers to the engagement of individuals in science as enthusiasts or amateurs.	Haklay, Basiouka, Antoniou, & Ather (2010)
Community-Based Participatory Research (CBPR) focuses on conducting research with and not on community members.	Minkler, & Wallerstein (2008)
Community Development explores how the local context shapes community development initiatives and projects.	Laverack (2006)
Community Science emphasizes the involvement of communities in science.	Nisbet & Scheufele (2007)
Criminal Justice and Law Enforcement investigates the implementation and effects of criminal justice policies within the broader social and legal context.	Sherman (1998)

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Research field	Reference
Crisis and Disaster Management engages the public, first responders, and relevant organizations in disaster preparedness, including response, and recovery efforts.	Boin & 't Hart (2003)
Crowdsourced Science is the practice of obtaining contributions to science from a large group of people.	Bonney, Shirk, Phillips, Wiggins, Ballard, Miller-Rushing, & Parrish (2014)
Cultural Heritage and Archaeology involves communities and stakeholders in preserving and interpreting cultural heritage and archaeological sites.	Smith & Waterton (2009)
Education and Curriculum Development actively involves students, parents, and educators in the design and improvement of educational programs and curricula.	Stoll, Bolam, McMahon, Wallace & Thomas (2006)
Education Policy and Reform investigates the implementation of education policies in schools and how local contexts affect student outcomes.	Coburn & Penuel (2016)
Energy and Environmental Policy encourages stakeholder engagement in energy policy and environmental regulation to address climate change and energy transitions.	Popp (2002)
Environmental Conservation and Natural Resource Management explores how the environmental and social contexts of regions affect conservation and resource management efforts.	Armitage, Marschke & Plummer (2008)
Environmental Management and Sustainability involves stakeholders in environmental decision-making, conservation efforts, and sustainable resource management.	Reed & Curzon (2011)
Global Health investigates the implementation of health interventions in diverse international settings.	Atun, de Jongh, Secci, Ohiri & Adeyi (2010)
Healthcare Delivery and Health Services Research explores how healthcare interventions and services are implemented in different healthcare settings.	Greenhalgh, Robert, Macfarlane, Bate & Kyriakidou (2004)
Implementation Science investigates the processes and factors influencing the successful integration of evidence-based practices into real-world settings.	Proctor, Powell & McMillen (2013)
International Development tries to understand how development projects and policies work within specific socio-cultural and political contexts.	Easterly (2006)
Participatory Action Research (PAR) involves collaboration between researchers and citizens in addressing social and community issues.	Reason, & Bradbury (2008)
Participatory Arts and Culture Research involves communities and artists in cultural research and creative expression.	Seelig & Aron (2017)
Participatory Design (PD) engages end-users and stakeholders in the design process of products, systems, and services.	Schuler & Namioka (1993)
Participatory Evaluation is a collaborative evaluation processes that engages stakeholders in assessing the effectiveness of programs and interventions.	Fetterman (2013)
Participatory GIS (PGIS) involves communities in co-creating geographic information systems for decision-making and planning.	McCall & Minang (2005)

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Research field	Reference
Participatory Rural Appraisal (PRA) is a research approach in which local communities identify and solve their own problems.	Chambers (1994)
Participatory Urban Planning involves residents and stakeholders in urban planning and development decisions.	Healey (1997)
Patient-Centered Research engages patients, healthcare providers, and communities in healthcare research and decision-making processes.	Abelson et al. (2013)
Public Participation in Scientific Research (PPSR) encompasses various forms of public engagement in science.	Shirk, Ballard, Wilderman, Phillips, Wiggins, Jordan, & Bonney (2012)
Public Policy and Governance encourages stakeholder and public participation in policy formulation, implementation, and evaluation.	Bryson, Quick, Slotterback & Crosby (2013)
Public Policy Evaluation considers how specific implementation contexts affect policy outcomes and effectiveness.	Mayne (2008)
Urban Planning and Development involves residents, businesses, and local organizations in urban planning and development decisions.	Innes & Booher (2010)
Volunteer monitoring involves individuals volunteering their time to collect scientific data.	Conrad, & Hilchey (2011)

As mentioned before, more traditional research fields often try to control or tolerate the context. Citizen science has an explicit focus on active participation of citizens throughout the research process. This specific focus on participation and collaboration makes it necessary for researchers to have tools to engage citizens and other stakeholders effectively. The aim of this guide is to offer guidance on methods to effectively engage citizens and other stakeholders in citizen science. To reach this goal, a mixed method approach, combining a literature review with case studies integrated in podcasts and a Delphi procedure, was used.

The first chapter of this guide will give an overview of frameworks or engagement models. The emphasis is not just on engagement for engagement's sake, but on fostering a holistic approach.

The next chapter underscores the importance of defining different target groups. Acknowledging the diverse nature of research projects and real-life contexts, it advocates for models that can be tailored to specific contexts. Lastly, the guide gives an overview of engagement strategies. Apart from reviewing relevant literature, each partner institution identified five case studies for which inspiration was drawn for the Delphi study (three case studies per partner institution) and the podcasts (two case studies per partner institution).

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2 Models of engagement

Given that engagement is crucial in citizen science, it is important to create a structured comprehensive framework or model for each research project. By creating an engagement model, citizen scientists can be engaged in a strategic way. Creating a specific engagement model for a citizen science project can create a more holistic approach to how citizens are engaged, taking into account project goals, communication strategies, citizen and stakeholder training, ethical guidelines, data quality assurance and long-term sustainability. One commonly cited limiting factor in citizen science are questions about the quality of the data gathered by citizens (e.g., McKinley et al., 2017). Being intentional in the engagement strategies and the need for training can increase the data quality. At the same time, citizen science projects are often in need of adaptable and flexible approaches, allowing customization of the model to the specific context. Models of engagement can ensure alignment with project goals and objectives, while also providing a structured and systematic approach to engagement (e.g., Shirk et al., 2012). A clear and adaptive outcome can help guide the citizen science project on what to specifically measure. For example, Crall and colleagues (2013) found different results depending on how context-specific their outcome measure was. Moreover, being intentional in the engagement strategies in use and their objectives can foster a sense of community and trust between citizens (Dickinson et all., 2012). The following factors can be taken into account when creating an engagement model for your citizen science strategy.

2.1. Project goals and objectives

It is important to be intentional about how citizen and stakeholder engagement contributes to meeting the project goals and objectives. For one, data quality is often questioned when citizens are actively involved in research activities (McKinley et al. ,2017). Clearly adjusting engagement strategies to the project goals and objectives can enhance scientific rigour by ensuring citizens have the support to continuously stay engaged and follow research protocols.

Raddick and colleagues (2010) found that contributing to science was a motivating factor for citizens to engage in citizen science. As such, being clear about the project objectives and how to communicate these with citizens can already be an engaging factor. From a practical perspective, being clear about the project goals and aligning these well with the engagement model can ensure efficient use of resources (Eveleigh et al., 2014) and clear communication between researchers and citizens (Shirk et al., 2012). Given that a common goal of citizen science projects is to reach certain learning outcomes in citizens, Phillips, Ferguson and Minarcheck (2015) provide a framework to support choosing intended learning outcomes. According to the authors, commonly

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desired and achievable learning outcomes concern 1) interest in science and the environment, 2) self-efficacy for science and the environment, 3) motivation for science and the environment, 4) content, process, and nature of science knowledge, 5) skills of science inquiry and 6) behaviour and stewardship.

2.2. Levels of engagement

A second factor to take into account is the desired level of engagement for different target groups. Recognizing that different levels of engagement might be reached or even desired from different target groups allows for tailoring engagement strategies to these specific groups (Jennet et al., 2016). A well-designed engagement model allows for this kind of adaptability and flexibility. From some groups a high level of engagement and participation might be desired, while others might just act as intermediaries. Moreover, by recognizing differences in engagement level and explicitly tailoring strategies to different groups, the contributions of diverse groups of citizens and stakeholders can be maximized (Raddick et al., 2010). As a result, taking into account engagement level differences can support long-term participation in the citizen science project (Eveleigh et al., 2014). In addition, since taking into account engagement level differences ensures citizens with varying abilities and time availability can participate, it leads to a more inclusive research design (Shirk et al., 2012). Lastly, different levels of engagement can impact data quality. Explicitly recognizing varying levels of engagement can help in implementing strategies to maintain data quality (McKinley et al., 2017). Given the importance of recognizing different levels of engagement in creating an engagement model for your citizen science project, the next chapter is dedicated to levels of engagement.

2.3. Defining target groups

When considering various engagement levels, it is important to separate different target groups. As a result, engagement strategies can be tailored to the different groups of citizens and stakeholders (Simpson, McFadgen, Edmonson, & Beza, 2021); Citizen Science in an Indigenous Context: A Delphi Assessment of Success Criteria for Engagement in Projects with Indigenous Communities. Frontiers in Communication, 6, 8.). Similarly to taking into account different engagement levels, defining specific target groups can have comparable results. Specific needs, interests and preferences of different subgroups can be considered in order to maximize engagement with the citizen science project (Shirk et al., 2012). Aligning with the specific needs and interests of specific subgroups can also maximize the impact of the citizen science project (McKinley et al., 2017), since the research project will have to focus on needs identified by citizens and other stakeholders in the real world. As mentioned before, efforts to tailor strategies to specific subgroups can lead to a more

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inclusive research design since a diverse range of citizens and stakeholders can be included in the project (Bonney et al., 2009), and to more efficient resource allocation (Eveleigh et al., 2014) by focusing the majority of resources on subgroups that can make the most meaningful contributions to the citizen science project. In addition, citizens will be more satisfied when they notice that a research project is designed with their interests and concerns in mind (Raddick et al., 2010). Lastly, adapting data collection techniques and training to previously defined target groups will result in higher data quality, and data which is more relevant to the research objectives (Wiggins & Crowston, 2011). In conclusion, defining target groups in the development of an engagement model for citizen science is crucial in order to customize engagement strategies. Given the critical importance of defining different subgroups, chapter 4 will go more into detail on defining target groups.

2.4. Engagement strategies

Clearly defining engagement strategies is a crucial step in designing an engagement model for a citizen science project. As previously mentioned, it is important to match the specific engagement strategies to the target group(s) at hand (Nov, Arasy & Anderson, 2011). Making intentional decisions about which engagement strategies to use can maximize participation of citizens and other stakeholders (McKinley et al., 2017), ensure efficient resource allocation (Eveleigh et al., 2014), enhance citizen and stakeholder motivation (Raddick et al., 2010) and ensure data quality (Dickinson et al., 2012), given that engagement strategies are the core of developing an engagement model for a citizen science project.

2.5. Ethical considerations

The main characteristics of citizen science are participation, inclusion and engagement of citizens and stakeholders. As a result, citizen science brings about distinct ethical considerations compared to more traditional research. Ethical concerns range from data protection, decision making authority to power sharing (Groot & Abma, 2022). Questions concerning decision making authority encompass issues about who has the power to make decisions, who gets to participate in which stage of the research process, and, conversely, who is excluded. It is critical to be conscious of these issues when designing a citizen science project and to maximize measures to ensure decision-making processes related to the project are inclusive and equitable (Irwin, 1995). In a similar vein, citizen science aspires to ensure equal power among all citizens and stakeholders. However, this is a complex ethical challenge which requires transparency and active efforts to keep the power dynamics in check (Bonney et al., 2014). A related issue is that diverse sources of knowledge need to be valued equally in citizen science projects (Tengö et al., 2017). Citizens and

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other stakeholders possess knowledge that greatly differs from traditional research conventions. Recognizing that this type of knowledge is equally valuable in a citizen science project is an ethical challenge.

Ethical issues in citizen science often revolve around power differentials, partnerships, and the nature of collaboration between academic and non-academic participants (Groot & Abma, 2022). In order to navigate these ethical challenges, ethical reflection should be regarded as a collaborative undertaking. Researchers should engage in partnerships with non-academic participants to collectively reflect on and address ethical challenges. This reflective approach is a pathway to achieving ethical citizen science, where the principles of equity, inclusion, and shared decision-making are upheld in practice.

Groot and Abma (2022) identify seven types of ethical work that researchers in citizen science need to do; 1) framing work in which the ethical scope and boundaries of the research are defined, 2) role work in which the roles and responsibilities of various target groups are clarified, 3) emotion work in which the emotional aspects of ethical issues are acknowledged and addressed, 4) identity work in which researchers reflect on their own ethical identity as a researcher, 5) reason work in which ethical reasoning and decision-making is enacted, 6) relationship work in which relational dynamics between academic partners and non-academic stakeholders are ethically managed, and 7) performance work in which ethical principles are enacted in practice.

2.6. Data Quality Assurance:

As previously mentioned, one of the main concerns of citizen science is ensuring that data quality is guaranteed. As such, incorporating robust data quality assurance measures is key (McKinley et al., 2017). For one, high-quality data is more likely to be accepted and found credible by the scientific community. Ensuring the collected data is reliable and valid enhances the quality of research outcomes (Bonney, et al., 2009). Moreover, citizen science studies often have the intent to influence decision-making processes. Given that accurate information is needed in order to formulate effective policies and interventions, high-quality data is crucial for decision-making processes (Dickinson et al., 2012) and influencing policies (Irwin, 1995). Citizens and stakeholders can feel more engaged when they notice the data they've gathered is useful and influential. Thus, high-quality data can instill trust and a sense of accomplishment, ultimately leading to continued participation (Bonney, Phillips, Ballard, & Enck, 2016; Eveleigh et al., 2014; Raddick, et al., 2010). High-quality data collected through citizen science projects can influence policy decisions and practices, as policymakers are more likely to consider data that has undergone rigorous quality control.

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3 Levels of engagement

In citizen science, recognizing that participants have varying levels of interest, expertise, and time commitment is crucial. Tailoring your project to accommodate these differences ensures inclusivity maximizes engagement from each target group. One framework that can be helpful to map out the desired engagement level from each subgroup, is the model designed by Shirk and colleagues (2012). This model distinguishes between the following five types of citizen science based on the level of participation:

1. **Contractual**: In these projects researchers receive a request to conduct a specific research project and report on the results, creating a very low level of engagement.
2. **Contributory**: In these projects the primary role of citizens is data collection, while researchers analyse the data. They often follow specific protocols for data collection but are not involved in project design or decision-making, leading to a low level of engagement.
3. **Collaborative**: In these projects, researchers still design the research projects, while citizens collect data, help refine project design, analyse data and/or disseminate results of the project. Although they do not have a significant role in project design, these projects involve a good level of engagement.
4. **Co-created**: In these projects researchers and citizens work together to design the research project and at least part of the citizens are actively involved in the majority or all phases of the research project. Participants actively contributing to project design, defining research questions, and making decisions results in a high level of engagement.
5. **Collegial**: In these projects citizens themselves conduct a research project independently with varying degrees of expected recognition for their contributions. Collegial projects, community members and scientists form partnerships to address local environmental issues. Citizens are sometimes recruited by the university, providing them with a strong say in shaping the research agenda and methodology. These projects involve the highest level of engagement.

Several other frameworks exist that can be used to map the level of participation you desire or that is feasible from different target groups. The above distinctions are often used to help researchers and practitioners understand and communicate the degree to which citizen scientists are actively involved in the research process. They are not rigid categories but rather a way to describe and classify the nature of engagement within specific citizen science projects. The level of engagement can vary from one project to another, and some projects may incorporate elements of more than one type.

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3.1. Defining the level of participation

Defining the level of participation in a citizen science project is crucial in adjusting engagement strategies to specific target groups. Firstly, it helps in setting clear expectations for citizens and other stakeholders. Knowing what role they play and how much influence they have in the project can enhance their experience and satisfaction. Secondly, it aids in designing effective communication strategies. If participants understand their level of involvement, communication can be tailored to provide the right amount of information and engagement. Thirdly, it contributes to the credibility and reliability of the scientific results. Understanding the extent of public participation allows researchers to account for potential variations in data quality across different levels of involvement. Lastly, it promotes transparency and trust. Clearly defining participation levels fosters trust between scientists and participants, as everyone understands their role and contribution in the collaborative scientific endeavour. Below, we discuss some models and methods that have been used successfully in the past to define the level of engagement, some best practices and challenges to ultimately increase engagement during the whole research project.

3.1.1. Arnstein's Ladder of Participation (1969)

The model of Shirk and colleagues (2012) seems to follow Arnstein's Ladder of Participation (1969). Arnstein's Ladder of Participation (1969) is a classic model for community engagement. The ladder categorizes citizen involvement into eight rungs, ranging from "manipulation" at the bottom to "citizen control" at the top, illustrating different levels of power and influence in decision-making. To determine the current rung or level of participation of a citizen in a research project, factors like the decision-making authority given to the citizen, transparency concerning the degree of information sharing and the extent to which the citizen's inputs are integrated into the final decision are considered. In citizen science, Arnstein's Ladder of Participation (1969) can be used to ensure the citizen's voice is taken into account in the decision-making process. Considering these factors that determine the level of participation, you can transform a citizen from being a passive spectator in a citizen science project, in a state of non-participation, to a co-creator of change, or in a state of citizen control. The ladder is a dynamic model so measuring where the citizen is on the ladder during the research project is an ongoing process. This ladder is a good tool to ensure all participants of the project are heard and that their input is highly valued, resulting in high engagement levels and participant involvement throughout the whole research project.

3.1.2. The Spectrum of Public Participation

The International Association for Public Participation (IAP2) developed a spectrum that outlines different levels of public participation, from "Inform" to "Empower." This model is widely used in participatory processes. The framework guides and assesses public participation in decision-

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making processes. It consists of five levels of engagement, each representing a different degree of public involvement.

1. **Inform:** Provide balanced and objective information by one-way communication from decision-makers to the public, e.g., fact sheets, informational websites.
2. **Consult:** Obtain public feedback on analysis, alternatives, and/or decisions. Two-way communication where decision-makers seek input but may not necessarily commit to integrating suggestions. E.g., surveys, public meetings, focus groups.
3. **Involve:** Work directly with the public throughout the process to ensure their concerns and aspirations are consistently understood and considered. Collaboration where public input influences decision-making, but decision-makers retain the authority. E.g., workshops, advisory committees, community forums.
4. **Collaborate** Partner with the public in each aspect of the decision, including the development of alternatives and the identification of preferred solutions. Joint decision-making where public and decision-makers share responsibilities. E.g., co-design workshops, consensus-building processes.
5. **Empower:** Lays the final decision-making in the hands of the public, within a full partnership where the public has the ultimate decision-making authority. E.g., participatory budgeting, community-led initiatives.

The IAP2 Spectrum provides a structured approach in citizen science projects to determine the level of public participation appropriate for a particular decision within the research project. Aligning with the above principles of the five degrees of involvement, it can raise the level of engagement of citizens.

3.1.3. The Ladder of Youth Voice

Hart (1992) is an important contribution to the understanding of how children can be involved in decision-making processes. Hart's (1992) work remains a foundational reference in the field of children's rights and participation, challenging traditional notions of how children are involved in decision-making processes and advocating for a more inclusive and participatory approach. To respect and recognize children's citizenship rights, Hart (1992) emphasises the importance of moving beyond symbolic gestures to genuine inclusion. Tokenism, or the symbolic giving of a voice, must also be avoided in citizen science projects so as not to compromise participant involvement.

The Ladder of Youth Voice, inspired by Arnstein's Ladder, is designed to encourage youth engagement and participation in projects and policy making. It offers seven rungs, each representing a level of youth involvement in decision-making processes.

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1. Non-Participation: These are decision-making processes in which youth have no active role or participation. Adults are making decisions on behalf of youth and their voices are entirely absent.
2. Decoration: Youth might be asked for their opinions or input concerning decision-making processes, but their opinions don't genuinely influence decisions.
3. Tokenism: Tokenism implies that youth participation is more than decoration, but their input is still seen as a formality. Decisions are primarily made by adults, and youth opinions may not carry significant weight.
4. Assigned but Informed: At this rung, youth are assigned specific roles or responsibilities in decision-making processes. They receive relevant information and are expected to contribute in defined ways, but the extent of their influence can be limited.
5. Consulted and Informed: Youth are actively consulted and informed about decisions. Their opinions are sought, and their input is considered in decision-making, though adults still hold the ultimate authority.
6. Adult-Initiated, Shared Decisions with Youth: At this level, decisions are made jointly by adults and youth. While adults may initiate the process, they actively involve youth in shaping and finalizing decisions.
7. Youth-Initiated and Directed: This rung represents a high level of youth engagement, where decisions are initiated, directed, and executed by youth themselves, with support from adults if needed.
8. Youth-Initiated, Shared Decisions with Adults: In this scenario, youth take the lead in initiating decisions, but they actively collaborate with adults to reach shared decisions.
9. Youth-Initiated and Controlled: At the top rung of the ladder, youth have complete control over decision-making processes. They initiate, direct, and make decisions independently.

3.1.4. The Citizen Science Engagement Continuum

McKinley et al. (2017) explores the role of citizen science in enhancing various aspects of conservation and environmental science. Involving citizens in scientific research can lead to significant benefits in terms of data collection, monitoring and understanding of ecological systems. This model emphasizes that citizen science projects can engage participants and stakeholders at varying levels of involvement and influence, from contributing data to collaborative decision-making and even community action. Some key aspects from the paper are discussed below:

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1. **Data collection:** citizen science can significantly expand the spatial and temporal coverage of data collection, involving tens of thousands of volunteers that gather more data than would be possible through traditional scientific methods alone. E.g., The increased data volume of citizens who participate in a national bird spotting campaign in their own backyards can contribute to a more comprehensive understanding of ecosystems.
2. **Public Engagement**: citizen science builds a sense of environmental stewardship among the public making them more conscious of conservation issues. This can lead to support for conservation initiatives and policy making but also a sense of ownership in community involvement.
3. **Policy making:** Engaging citizens in scientific endeavours enhances the likelihood of unexpected discoveries and generates information that informs policymaking, planning, and management efforts across different government levels. Citizen science can help identify patterns and gaps and help set priorities and allocate resources.
4. **Education:** citizen science offers the opportunity for a transparent discussion grounded in scientific understanding. that more people can access, understand, and trust. By increasing scientific and environmental literacy, public involvement is enhanced in decision-making by natural resource and environmental managers and other decisionmakers.

3.1.5. Educational Citizen Science.

Educational Citizen Science involves incorporating citizen science projects into educational settings to enhance learning experiences. Kountoupes and Oberhauser (2008) say that educational projects focus on enhancing participants' scientific literacy and understanding through hands-on experiences. They often involve students and educators, with learning as a primary goal. This approach leverages the enthusiasm and curiosity of students, teachers, and the general public to contribute to real scientific research while gaining valuable educational benefits. Some key learnings from Mebert and Yezbick (2020) on Educational Citizen Science are listed below.

1. **Engagement**: It provides a hands-on and engaging way for students to explore scientific concepts and methodologies. Participation in citizen science projects allows students to actively contribute to authentic research, fostering a deeper connection with the subject matter.
2. **Interdisciplinary Learning:** Educational Citizen Science often involves interdisciplinary themes, allowing students to apply knowledge from various disciplines, including science, technology, engineering, and mathematics (STEM). This interdisciplinary approach mirrors real-world scientific practices.

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3. **Critical Thinking:** Students develop critical thinking and problem-solving skills as they actively participate in the scientific process. They learn to formulate hypotheses, collect and analyse data, and draw conclusions, contributing to their overall scientific literacy.
4. **Community Involvement:** These projects often encourage collaboration within the community. Students may work on projects that address local environmental issues, promoting a sense of responsibility for their surroundings and fostering community engagement and ownership.
5. **Technology Integration**: Educational Citizen Science frequently incorporates technology, utilizing online platforms and tools for data collection, analysis, and collaboration. This integration enhances students' technological literacy and prepares them for the digital aspects of modern scientific research.
6. **Citizenship Skills:** Beyond scientific knowledge, students develop skills related to responsible citizenship. They learn about the importance of contributing to a collective understanding of environmental issues and the role of informed decision-making in societal well-being.
7. **Real-World Applications:** By participating in projects with tangible outcomes and real-world applications, students can see the impact of their contributions. This connection to real-world issues enhances their motivation and appreciation for the relevance of scientific inquiry.
8. **Teacher Professional Development:** according to Sancar and colleagues (2021) and Willemse and colleagues (2015) Educational Citizen Science and citizenship education involves teacher training and professional development opportunities. Teachers gain new skills, resources, and strategies to integrate citizen science into their curriculum effectively.

Overall, Educational Citizen Science serves as a powerful tool for promoting inquiry-based learning, fostering scientific curiosity, and nurturing a sense of environmental responsibility among students. It aligns with contemporary educational approaches that emphasize experiential learning and the integration of real-world contexts into the curriculum.

Educational citizen science represents a higher level of engagement by immersing participants in authentic scientific practices, encouraging inquiry-based learning and connecting classroom activities to real-world applications. This approach enhances the educational experience by making it more active, relevant and meaningful for participants.

3.1.6. Extreme Citizen Science

Harkley (2013) discusses Extreme Citizen Science or ExCiteS as an approach to include individuals from diverse backgrounds and those with limited formal education and aims to democratize

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participation in scientific research and data collection. The term "extreme" in this context refers to the inclusivity of the approach, reaching out to people in extreme or diverse situations, such as remote or marginalized communities, and all participants are deeply involved in the whole research process through co-creation. Smith (2022) also writes on behalf of the European Commission '*Extreme Citizen Science gives a voice to the marginalised in remote communities'.* As internet and smartphone use becomes more ubiquitous, so too is the development and use of mapping and data collection applications able to support digitally enabled citizen science initiatives in rural and remote regions (Kar et al., 2016; Pejovic & Skarlatidou, 2020).

Citizen science is increasingly recognized and valued in community-led conservation initiatives (Pimm et al., 2015). Extreme Citizen Science represents a high level of engagement in citizen science, and it can be considered a form of deep or participatory engagement, referring to best practices from Chiaravalloti et all (2022):

1. **Inclusivity:** ExCiteS emphasizes the inclusion of individuals who may not have formal scientific training. It aims to empower people from various communities to actively participate in the scientific process.
2. **Diverse Participation:** The approach recognizes and values the knowledge and expertise that individuals from diverse backgrounds bring to scientific research. This includes working with local communities, indigenous groups, and others who may have unique insights into their environments.
3. **Technology Integration:** This form of citizen science often leverages technology, including mobile devices and online platforms, to facilitate data collection, sharing, and analysis. This integration of technology enables broader participation and the collection of large datasets.
4. **Local Relevance:** ExCiteS projects typically address issues that are locally relevant and significant to the participating communities. This ensures that the scientific research directly contributes to addressing local challenges or concerns, simultaneously having an eye for and using local community opportunities.
5. **Capacity Building**: The approach focuses on building the capacity of individuals within communities to actively engage in scientific research. This includes providing training and resources to empower participants to lead and manage their own projects.
6. **Ethical Considerations:** Extreme Citizen Science emphasizes ethical considerations, including respect for local knowledge, cultural sensitivity, and ensuring that the benefits of the research are shared with the participating communities.

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7. **Citizen as Scientist:** In ExCiteS, participants are not just contributors of data but are considered co-researchers or citizen scientists. The approach recognizes the valuable contributions that individuals can make to the scientific process.

The goal of Extreme Citizen Science is to democratize science and make it accessible to a wide range of people, enabling diverse communities to actively contribute to and benefit from scientific knowledge. It aligns with the principles of participatory research, acknowledging that everyone, regardless of their background, can play a role in advancing scientific understanding, thus promoting a very high level of engagement.

3.2. Interaction between engagement, research activity and level of expertise of the participant

Managing a large number of volunteer contributors and their contributions poses significant challenges in terms of motivation, quality control, and overall project management. It's crucial to consider the perspective of citizens both as producers (involved in tasks like data collection and classification) and consumers of the project's outcomes. Citizens are often motivated by the joy of participating in authentic scientific research, the prospect of learning, coupled with entertainment, and the opportunity to connect with new people, places, and diverse social and environmental contexts. Utilizing social tools such as forums, blogs, wikis, microblogs, and chats holds immense potential for facilitating the exchange of knowledge and experiences in this context.

The Internet and new mobile technologies have expedited citizen participation, leading to numerous successful cases. Yet, a key challenge in citizen science doesn't solely stem from technology but rather from effectively managing, ensuring quality control, and sustaining engagement and motivation among participants.

Key factors for success include ongoing campaigns, user-friendly interfaces, tutorials, recognition, and feedback mechanisms, encompassing communication channels and the publication of results. Establishing direct communication channels and providing support are vital to maintaining continuous feedback between project managers and volunteer contributors. (Esteves et al., 2017)

Let us now have a look on how research activities can be assigned to the participant, by taking into account different levels of engagement and different levels of expertise; and how the nature of the activity has an effect on the participant involvement.

Although we should also keep in mind here that the degree to which the citizen wants to be involved with the scientific research is also going to have an effect on the task that the project leader is going to assign to the citizen as well. This can therefore be considered a negative spiral: the less involved

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the citizen is, the less complex the assigned task by the project leader and again the less involved the citizen will feel.

It is therefore necessary to communicate transparently and make a roadmap to further engagement, increasing the role of the citizen, accessible; so as soon as the ambition to take up a more prominent or involved role arises, the participants know which steps to take.

1. **Basic or entry-level participation** refers to the foundational or introductory level of involvement in a particular activity or project.
    a. Tasks / activities: In the context of citizen science or other community initiatives, individuals with entry-level participation typically engage in fundamental tasks or activities, often focusing on activities such as data collection, basic observations, or other introductory responsibilities.
    b. Level of expertise: This level of participation serves as the starting point for individuals who are new to the project, allowing them to become familiar with the goals, processes, and expectations before potentially progressing to more advanced roles. Minimal prior knowledge or experience in scientific endeavours is required. They offer accessible and straightforward tasks that require little to no specialized skills.
    c. Participant involvement: allows individuals to become familiar with the research project, enhancing basic skills e.g., to use specific tools, building confidence, understanding their contribution and a clear view on progression opportunities to more advanced roles will increase participants engagement.
2. **Intermediate engagement** refers to a level of involvement that falls between basic or entry-level participation and more advanced or leadership roles.
    a. Tasks / activities: In the context of citizen science or community initiatives, individuals with intermediate engagement may have progressed beyond introductory tasks but haven't yet taken on leadership responsibilities. This level of engagement often involves participants in slightly more complex tasks.
    b. Level of expertise: More complex tasks require a moderate level of expertise. Activities such as data analysis, project coordination, or playing a role in the decision-making process, showcasing a deeper commitment and understanding compared to those in the early stages of involvement. Participants at this level may engage in basic data analysis or contribute to project design discussions.

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c. Participant involvement: increased complexity of task can develop the participant's skills, expanded responsibilities and leadership exposure, as some participants begin to take on leadership roles and deepen their engagement.

3. **Advanced Involvement:** Advanced involvement refers to a high level of participation and engagement in a particular activity, project, or field. In the context of citizen science or community initiatives.

   a. Tasks/activities: individuals with advanced involvement often take on leadership roles, contribute to project design, and may engage in more complex tasks like decision-making, mentoring others, data interpretation, collaboration with scientists in project planning, or even co-authorship on research papers.

   b. Level of expertise: a deeper understanding of the subject matter and a greater commitment to the overall goals of the project. Advanced involvement may also involve collaboration with professionals, integration into research communities, and a significant contribution to the project's success.

   c. Participant involvement: participants seeking a deeper commitment, advanced involvement may take on leadership and mentorship roles. Having a sustained commitment and possessing significant expertise, they can be a mentor to new participants or assist or even take the lead in the development of future citizen science projects. Successfully handling complex tasks and simultaneously helping others to develop themselves, will give a sense of achievement.

3.3. Enhancing the level of engagement

3.3.1. Project design phase

A detailed project plan, including timelines, resources and tasks with defined roles and responsibilities for citizens will lead to higher engagement of the participants. In the development phase of a research project careful consideration should be given to designing the project with flexibility. This involves allowing participants to choose their engagement levels based on their skills, availability and interests. Ensure that tasks are clear, achievable, and have a meaningful impact on the research.

The usage of scenario modelling is recommended when there are threats of data incompleteness, caused when critical aspects that ensure data reliability and accuracy are no longer met. Mair & Ruusalepp (2016) advise to build in data collection protocols, that highlight the importance of establishing clear and standardized data to all participants. Pre-data collection training, regular

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checks and validation procedures can be given. A well-designed feedback mechanism will make it easier to address data collection issues during the research process and, in the meantime, also provide greater transparency and will contribute to the credibility of the collected information.

3.3.2. Project execution phase

Technology and Tools

Utilize user-friendly technology and tools to streamline data collection, analysis, and reporting processes. Easy-to-use apps and platforms can reduce barriers to participation. Ensure that the technology used is accessible and works on various devices and operating systems. Address issues related to accessibility and diversity to ensure that everyone has an equal opportunity to engage.

Communication

Tailoring communication channels (Newman et all, 2012) and providing support are vital to engage volunteer contributors. Using clear communication about the different levels of engagement within your project and providing simultaneously accessible pathways for participants to progress from entry-level activities to more advanced roles, will contribute to the project overall engagement level. Stay transparent and value the voice of each participant, avoid tokenism at all costs so trust can be built to enhance engagement, ensuring the success of the project (Hart,1992).

Encourage collaboration among participants by fostering a sense of community and shared purpose. Facilitate communication and knowledge sharing among participants to build a sense of belonging. Clearly communicate how the research contributes to solving real-world problems or advancing scientific knowledge. Participants are more engaged when they understand the significance of their contributions.

Monitoring and controlling engagement

Once all participants' engagement levels are defined, it becomes crucial for the overall project outcome to consistently work towards achieving and maintaining a certain level of engagement in a citizen science project. Continuously defining and measuring the level of participation in a citizen science project, and acknowledging this is a dynamic given, as described in Arnstein's Ladder of Participation (1969), is essential for fostering increased engagement from all participants in the research project.

And lastly acknowledge and reward participants at each level, during each phase of the execution of the research. This could include certificates for completing entry-level tasks, acknowledgment in publications for more involved roles, or leadership recognition for those in mentorship positions.

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Keep participants informed about project developments, research findings, and future plans. Consider strategies to retain participants over the long term. This might involve offering opportunities for more advanced roles or ongoing projects. Continuously gather feedback from participants to assess their experiences and make improvements to the project based on their input.

Training and support

The provision of training and support in citizen science projects plays a crucial role in influencing the engagement of participants. Comprehensive training empowers citizens with the necessary knowledge and skills to actively contribute to the scientific process. Participants who feel confident and capable are more likely to be engaged and motivated to contribute effectively to the project. Clear understanding of the project's purpose helps participants connect with the broader goals, fostering a sense of purpose and commitment.

Training contributes to skill development, whether it's in data collection, use of specific tools, or understanding scientific methodologies. Participants are more likely to find the tasks, where they can continuously learn from more enjoyable and fulfilling, leading to sustained engagement.

Provide training sessions and workshops to equip participants with the necessary skills and knowledge to effectively contribute to the research activities. Offer ongoing educational opportunities and resources to support participants in their roles.

Support involves ongoing communication channels for participants to seek assistance or share experiences. A responsive support system fosters a sense of community and connection, reinforcing participants' engagement over time. A sense of belonging to a community of like-minded individuals enhances engagement, as participants feel part of a collaborative effort.

Training and support also make it possible to give feedback and recognition, making participants feel equipped to handle diverse scenarios and more likely to stay engaged, even in changing or unpredictable circumstances.

In summary, effective training and support mechanisms not only equip citizens with the necessary skills but also create an environment that fosters a sense of belonging, purpose, and continuous learning. These factors significantly contribute to the sustained engagement of participants in citizen science projects. (EU-Citizen Science, 2021)

3.3.3. Post-research maintenance phase

Acknowledging Participant Contributions

The chapter titled “Models for developing citizen science projects” by Bonney et all (2016) explores various models and strategies acknowledging participant contributions. It emphasizes the

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importance of recognizing and acknowledging the valuable contributions made by citizen scientists. Acknowledgment serves as a form of appreciation for the time and effort invested by participants.

By recognizing and accommodating various levels of engagement, your citizen science project becomes an inclusive and dynamic ecosystem, welcoming participants with diverse backgrounds and interests. This approach not only enhances the overall project experience but also contributes to the richness of the scientific contributions from your community.

Higher levels of recognition reflect in promoting inclusive authorship, where citizen scientists are credited for their contributions in scientific publications or organizing public recognition events, such as ceremonies, where citizen scientists are celebrated for their contributions.

By acknowledging participant contributions to community building and networking within the citizen science community it will foster a sense of belonging and encourages ongoing involvement. Also, the continuous communication with participants, expressing gratitude and maintaining an open dialogue to acknowledge their ongoing commitment further enhances this effect.

Acknowledging participant contributions is crucial for the success and sustainability of citizen science projects. It not only recognizes the efforts of individuals but also strengthens the relationship between scientists and citizen contributors, fostering a collaborative and inclusive scientific community.

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4 Defining target groups

There are different terms used to refer to non-professional scientists: *amateurs, hobbyists, citizens, citizen researchers, individual citizen researchers, collaborators, community, community researchers, contributor, donor, local knowledge expert or holder, lay knowledge holder, general public, layman, participant, partner, volunteer, volunPeer, non-credentialed researcher, non-academic, non-scientist, the people, the crowd*, etc. (Eitzel et al., 2018, Mahr et al., 2017) Many of these terms might have a negative connotation, or they do not cover what participants in citizen science projects actually do (Land-Zandstra et al. 2021, Eitzel et al. 2018), yet to some extent they give hint to wide-spectrum of target groups having potential to be involved in citizen science projects. Engagement as such is not an abstract concept and it must be contextualized in a specific environment - the diversity of used terminology is also due to the large number of citizen science projects and their specifics, which already indicate that citizen science involves different target groups.

The possibility that academic researchers have not fully grasped the opportunities offered by the involvement of diverse groups of citizens and individuals in science is also implied by Pateman et al. (2021) who argue that “it is unclear how diverse citizen science participants are” and there are inequalities represented in citizen science that should be addressed. Füchslin, Schäfer, & Metag, (2019) draw attention to factors such as why potential of engagement cannot be realized fully by involving more diverse target groups – researchers might not be aware of certain groups’ interest in citizen science projects, or the project organizers do not manage to reach interested groups. However, not all groups have interest and/or opportunities (lack of knowledge, free time, access, etc.) to participate in citizen science, so there are limits to reducing unequal participation.

Previous studies have shown both the structure of the different groups involved in social science and the socio-demographics of the individual participants. Thus Göbel et al. (2017:17) identified several types of stakeholders in citizen science projects: (1) *Civil society organizations, informal groups and community members*; (2) *Academic and research organizations*; (3) *Government agencies and departments*;(4) *Participants; (*5) *Formal learning institutions such as schools*; and (6) *Businesses or industry*. Not all stakeholders` groups demonstrate equally high interest to engage; for example, NGOs frequently show higher activity and thus it takes less from project organizers to engage them.

There are some studies that provide information about socio-demographic characteristics of citizen scientists. Pateman et al. (2021) have discovered that minority ethnic groups are less likely to participate in the United Kingdom. The researchers also found out that declining socio-economic status can negatively impact participation of white ethnic groups in science projects, but it was not

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the case for minority ethnic groups. Higher level education is related to more active participation in science, while being unemployment has a negative effect on participation. Middle-aged people or older are more likely to be engaged in sciences. (Pateman, 2021:1) According to Curtis (2018) analysis of online citizen science projects, a typical participant is likely to be a well-educated male with an existing interest in science or computing. In the context of participants' interest, she also points to the importance of having a wider interest in science and science-related activities such as reading popular science books, visiting science centres, and looking at science-related websites (Curtis, 2018 as cited in Füchslin, Schäfer, & Metag, 2019). A recent study on citizen science's impact on science also defines a level of knowledge, scientific skills and attitude towards science as critical factors influencing participation (von Gönner et al. 2023). Overall previous studies agree that non-professional participants in science are mostly men, white and highly educated full-employment individuals (Füchslin, Schäfer, & Metag, 2019; Terenzini, Safaya, & Falkenberg, 2023). It should also be noted here that for academic researchers working with citizen science projects, some groups are more accessible than others, such as students, NGOs and other partners in the discipline.

The review of previous studies demonstrate that some groups are engaged in citizen science projects more frequently. Engagement of less represented groups takes more efforts and other resources; thus, it may be both costly and time-consuming and these resources are not always available to science projects. The E3UDRES2 Ent-r-e-innovators project analysis on citizen science activities in partner organizations also reveals that while there have been projects involving socially disadvantaged individuals, unemployed and with low levels of education, the involvement process has been rather challenging. For example, it is likely there will be a need to apply informal methods to facilitate conversation between vulnerable participants and project organizers, to build trust and to establish personal relationship. Frequently there is a link between the responsibilities trusted to citizen scientists and the number of participants. It is likely that more demanding responsibilities will limit the number of the participants – it takes time and other resources to prepare and train participants to perform and achieve the project objectives.

4.1. What motivates citizen scientists to engage

Potential citizen researchers can come from varied social backgrounds, have different experiences and other personal attributes, circumstances and their motivations to engage in citizen science are different. According to the previous studies, project organizers frequently do not have sufficient information about their potential target groups, or their motivations, which is important for recruiting and sustaining citizen participants.

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West & Pateman (2016) have carried out research on recruiting and retaining citizen participants and have found there is not enough knowledge on citizens' motivation to engage in science. Land-Zandstra et al. (2021) suggest that motivations for engagement in general are similar to motivations for participation in citizen science. According to West & Pateman, knowledge about volunteers' motivation is helpful because there are a number of important similarities between volunteers and citizen researchers. Citizen participants can have multiple motivations and according to the authors, understanding them is a precondition for effective engagement. Asingizwe et al. (2020) have identified several turning points in the context of motivation emphasizing project organizers should take into account not only motivation and barriers to enter in the project, but also changes of participants' motivation & barriers during the project activities. West & Pateman (2016) have presented several stages of citizen researcher journey and emphasize the importance of monitoring changes of participant motivation, adjusting tasks for participants to make sure they match the transformation of motivation. Meaningful tasks are clearly important in attracting and retaining the interest of participants. However, it should be noted that the project culture, where the project funder might restrict changes during the project, is not always flexible enough to accommodate changing needs of citizen scientists.

Table 2: Participant journey stages in a project and a checklist for project organizers corresponding to each of these stages

Stage of participant journey	Checklist for project organizers corresponding to each of stages to maximize the experience of participants
Project planning	– Find out what people`s motivations might be for participating in a project – Make sure the project is well organized with clear expectations and meaningful tasks – Create tasks that appeal to different motivations – Consider the potential barriers to participation and how to overcome them – Design monitoring and evaluation plan
Awareness of opportunity and decision to participate	– Advertise to different groups through diverse means, including use of gatekeepers – Ensure a diverse range of people are represented in advertising materials – Appeal to a breadth of motivations in advertising – Make it clear what the project is about, what are the tasks' areas, and consider "taster sessions" for potential participants
Initial participation	– Make sure participants' expectations of the role, and the reality of the role match – pair the right person with the right role from the beginning – Consider providing opportunities for learning and development – Find out what motivated participants to join the project
Sustained participation	– Make sure the project is well organized with regular communication with volunteers – Provide volunteers with feedback to let them know their time is well spent – Try to understand how participants motivation is changed over time – Refine the project, if possible, to meet changing motivations, or provide alternative tasks for participants – Provide opportunities for participants to interact with each other

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Stage of participant journey	Checklist for project organizers corresponding to each of stages to maximize the experience of participants
	– Consider rewarding participants – Allow participants to change their role if needed
Finish participation	– Allow participants to have feedback and learn from the experience

Source: West & Pateman (2016)

Looking at West & Pateman's (2016) participatory journey and Asingizwe et al. (2020) study, it is evident that citizen engagement is a labour-intensive endeavour and a reduction in effort on the part of project organizers (e.g. communication with participants, adjusting tasks etc.) will result in a decrease in participatory activity. As previously stated, some target groups demand more effort to recruit and sustain interest to participate. There is also agreements that engagement of diverse target groups demands diverse communication types. According to Bonney et al. (2009: 980) ”Recruiting participants can be very simple or extremely challenging, depending on a project’s goals and audience.“, thus science projects design needs to include engagement and communication strategies. Project organizers should develop involvement plans that take into consideration specifics of each target group. Working with civic society organizations is important to facilitate the participation of specific target groups and individuals with a genuine interest in the topic. (Kieslinger et al., 2018).

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5 Engagement Strategies

Since having the appropriate engagement strategies for your target audience is core in creating desired participation levels from citizens and stakeholders, our aim was to provide an overview of possible engagement strategies. Firstly, Veeckman and colleagues (2019) created a practical guide containing engagement and communication strategies for citizen science. Factors that they deem important for increasing engagement overlap with variables already discussed in this guide, namely determining your project objective, defining the desired level of engagement, specifying your target audience, understanding motivating factors for your target audience, engaging and evaluating, levelling existing networks, offering a fun experience, using social media, using digital storytelling, gamification and finding project ambassadors.

Secondly, several research fields are akin to citizen science and also deal with issues related to engagement. One research field that is related to citizen science is implementation science. According to Bauer and Kirchner (2020) the goal of implementation science is twofold: 1) to identify which factors facilitate or act as a barrier to the uptake of an intervention across multiple levels of context, and 2) to implement strategies to enhance facilitating factors and overcome barriers to ultimately increase the uptake of research interventions. As such, the major difference between traditional research and implementation science is that implementation science aims to actively engage the research context instead of trying to control it. This is akin to citizen science where citizens and stakeholders act as the context. From the field of implementation science, Powell and colleagues (2015) made a compilation of strategies supporting the implementation of a research intervention or innovation. There is considerable overlap between engagement strategies aimed at citizens and stakeholders and strategies aimed at supporting the context – in this case citizens and stakeholders – to implement research interventions or innovations. Given this overlap, the compilation of implementation strategies created by Powell and colleagues (2015) was used as a starting point for creating an overview of engagement strategies.

5.1. Delphi Study

In order to create an overview of engagement strategies, a Delphi study consisting of three rounds was carried out with researchers who have expertise in citizen science. A Delphi study is a structured, iterative approach used to gather the collective knowledge of experts or stakeholders (Keeney, McKenna, & Hasson, 2001; Linstone, & Turoff, 2002). It involves a series of questionnaires or voting rounds that are administered to a panel of experts in multiple rounds, with feedback provided between rounds. The iterative nature of the Delphi study enables refinement over time, making it particularly useful for creating frameworks or models. The methodology of the

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Delphi study was based on the methodology used by Powell and colleagues (2015) for creating a list of strategies for implementation science. There is considerable overlap between the engagement of citizens and other stakeholders for citizen science and strategies intended to make sure the research context (e.g. citizens and other stakeholders) implements a research intervention or innovation. Thus, the compilation of implementation strategies designed by Powell and colleagues (2015) served as a basis for creating an overview of engagement strategies.

5.1.1. Participants

Members of the E³UDRES² consortium recruited experts in citizen science within their countries. 12 experts took part in the first round of the Delphi study. Two participants for the first round were from Austria, two from Belgium, four from Romania and four participants did not provide information about their country of residence. 16 experts filled in the survey for the second round of the Delphi study. One expert was from Austria, five from Belgium, three from Hungary, two from Latvia, one from Portugal, three from Romania and one expert didn't provide information about their country of residence. Nine experts participated in the third Delphi round, the consensus webinar. One participant to the consensus webinar resided in Austria, three in Belgium, one in Latvia, three in Portugal and one in Romania.

5.1.2. Methodology Delphi study

The modified Delphi process consisted of three rounds. During the first two rounds participants were able to offer feedback on a list of engagement strategies and their definitions via an online questionnaire. After each round, the strategies and their definitions were adjusted based upon participant feedback. The third round involved a live online voting process resulting in the final list of engagement strategies.

5.1.3. Round 1

The first part of the survey for Round 1 listed 52 engagement strategy terms and definitions based on two different sources, 1) strategies used in implementation science (Powell et al., 2015) and 2) recommendations by Scivil, the Flemish knowledge centre on citizen science (Veeckman et al., 2019). Each question included an engagement strategy, the definition of the engagement strategy, a text box where participants could write synonyms for the engagement strategy and a text box for further comments (including alternative definitions or concerns). Participants could propose additional engagement strategies in the second part of the first survey. Annex 1 gives an overview of the full survey for Round 1 for the Delphi study.

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5.1.4. Round 2

The survey for Round 2 of the Delphi study included the engagement strategies and their definitions from Round 1, additional engagement strategies identified in Round 1 of the Delphi study, along with a summary of the comments that participants provided regarding the engagement strategies. Engagement strategies were grouped together according to the feedback that was provided in Round 1 to increase efficiency to providing feedback. As in the first survey, participants could suggest alternative definitions, raise concerns or provide feedback concerning the engagement strategies. Additionally, participants could suggest additional engagement strategies. The full survey for Round 2 can be found in Annex 2. Engagement strategies which there were still concerns regarding the core definition were included in Round 3 of the Delphi study.

5.1.5. Round 3

Round 3 of Delphi study consisted of a live online polling and consensus process conducted via Teams in addition with WooClap. Participants received a guide describing the voting process before the start of the live polling (see Annex 3). During the live polling, definitions for seven engagement strategies for which alternative definitions were proposed in Round 1 or 2, were presented alongside their alternative definitions (see Annex 4). Since voting was more complex for engagement strategies with more alternative definitions, engagement strategies with only one alternative definition were presented first. In the first stage, “approval voting” used. Participants could endorse as many definitions (original or alternatives) as they saw fit. This methodology of voting promotes collaborative versus adversarial decision making concerning the definitions of the engagement strategies. In line with the methodology used by Powell and colleagues (2015), we used a cutoff of 60% approval for a specific engagement strategy definition. If a definition received more than 60% of votes and received more votes than alternative definitions, the definition was retained, and voting moved to the next engagement strategy. In two cases, no definition could be retained after approval voting. In these cases, the alternative definitions were discussed followed by “runoff voting”. In runoff voting, participants could only endorse one definition. Both cases were runoff voting had to be applied concerned engagement strategies for which participants could choose between three alternative definitions. In both cases, participants only endorsed two out of three potential definitions, either during approval voting (1st voting round) or runoff voting (2nd voting round). As a result, only one extra round of voting had to be organized in order to reach a majority for a specific definition in both cases.

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5.1.6. Delphi Study results

48 engagement strategies were retained based on the 3 Delphi rounds with the citizen science expert. Table 2 gives an overview of the engagement strategies that were retained and the definition that were agreed upon together with the citizen science expert.

Table 3: Overview of retained engagement strategies and their definitions

Engagement strategy	Definition
Adjust communication to target group	Create separate but coherent communication plans if you want to engage different target audiences (e.g., formal or informal tone, how to approach target audience, generic or specific or individual approach, …), incorporating both barriers and facilitators to communication encountered by different groups.
Alter patient/consumer fees	Create fee structures where participants pay less for preferred interventions or products (the ones being researched) and more for less-preferred interventions or products.
Assess engagement barriers and facilitators	Assess internal (intrapersonal) and external (environmental) factors that facilitate or hinder stakeholder and citizen engagement.
Audit and provide feedback	Collect and summarize data concerning stakeholder engagement over a specified time period and use it to monitor, evaluate, and modify engagement strategies throughout the project.
Build a coalition	Recruit and cultivate an ecosystem of partners, participants and enablers in the citizen science project.
Centralize technical assistance	Develop and use a centralized system to deliver technical assistance focused on issues related to the citizen science project.
Collaborative art installations	Create collaborative art installations that visually represent project data and engage the community in the artistic process.
Collaborative tools	Develop mobile apps that allow citizens to contribute data or participate in activities related to your project conveniently.
Conduct educational meetings	Hold meetings targeted toward different stakeholder groups (e.g., providers, administrators, other organizational stakeholders, community, citizens, patient/consumer, family stakeholders, …) to provide information about the citizen science project and educate them on related topics.
Conduct local consensus discussions	Include citizens and other stakeholders in discussions that address whether the chosen problem is important and whether the intervention and/or citizen science project to address it is appropriate.
Conduct local needs assessment	Consult with your target audience(s) to adjust your perception of them, identify their needs, wishes, requirements and barriers, and alter your engagement strategy and citizen science project accordingly.
Conduct ongoing training	Plan for and conduct training and personal coaching in the citizen science project to ensure that participants and citizen scientist have the necessary knowledge, skills and methods to contribute effectively to the project in an ongoing way.
Connect citizens with researchers	Have a trained person meet with citizens and other stakeholders with the intent of changing their behaviour and/or engagement to the citizen science project.
Create a learning collaborative	Facilitate the formation of groups of citizens or other stakeholder and foster a collaborative learning environment to improve engagement to the citizen science project.

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Engagement strategy	Definition
Create new innovation teams	Change who serves on the project team, adding different disciplines and different skills to make it more likely that the aimed innovation is delivered (or is more successfully delivered).
Define the level of engagement from different target groups	Define the level of engagement that you want from different target groups (e.g. citizens, organisations, family groups, other stakeholders, …). Split your audiences into primary, secondary and intermediary target audiences.
Define the stakeholders and their roles	Define the stakeholders that you need in your citizen science project and the role they will have in the project. When defining your target audience, you can consider the following: group size, age, gender, level of education, prior knowledge of the research subject, initial interest, engagement with the subject and your organization, etc.
Develop and implement tools for quality monitoring	Develop, test, and introduce into quality-monitoring systems the right input — the appropriate language, protocols, algorithms, standards, and measures (of processes, behavioural outcomes, implementation outcomes and engagement outcomes) that are often specific to the citizen science project.
Develop disincentives	Provide (financial) disincentives for failure to engage with the citizen science project.
Develop educational materials	Develop and format manuals, toolkits, and other supporting materials in ways that make it easier for stakeholders and citizens to learn about the citizen science project and (if applicable) for organizations to learn how to deliver the intervention.
Distribute educational materials	Distribute educational materials (including guidelines, manuals, and toolkits) in person, by mail, and/or electronically.
Engage stakeholders	Develop reminder systems designed to help stakeholders to recall information and/or prompt them to use the citizen science project.
Identify project ambassadors	Identify citizen scientist or stakeholders who can be ambassadors for the project. Ambassadors have been involved since the very beginning of the citizen science project, know a lot about your project's research topic and have a strong intrinsic motivation to participate.
Intervene with citizens and other stakeholders to enhance uptake and adherence to the citizen science protocol	Develop strategies with citizens and other stakeholders to encourage and problem solve around adherence to the study protocol.
Make inclusive project design choices	Adjust your citizen science project design and engagement strategies to include specific target groups (such as at-risk groups).
Make training dynamic	Vary the information delivery methods to cater to different learning styles and work contexts, and shape the training in the citizen science project to be interactive.
Obtain formal commitments	Obtain written commitments from key partners that state how they will be engaged in the citizen science project.
Organize fun and social activities	Organize activities where education about the citizen science project is combined with fun and social activities.
Organize regular stakeholder meetings	Introduce regular opportunities for contact in which you highlight once again the project aims, its benefits to the community and (interim) research results.
Promote adaptability	Identify the ways a citizen science project can be tailored to meet local needs and clarify which elements of the project must be maintained to preserve fidelity to the project (e.g. the degree to which the project is delivered as intended).

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Engagement strategy	Definition
Provide facilitation	Ongoingly facilitate stakeholders who will provide the innovation. Provide training for facilitators who will facilitate stakeholders who provide the innovation.
Provide incentives	Provide incentives or rewards as an extrinsic motivation for citizens and stakeholders to participate in the citizen science project.
Provide ongoing consultation	Provide ongoing consultation with one or more experts in the strategies used to support the implementation of the citizen science project.
Purposely monitor the implementation of the citizen science project	Monitor progress and adjust the citizen science project and implementation strategies to continuously improve the quality of the project.
Recruit, designate, and train for leadership	Recruit, designate, and train researchers and citizens for implementation of the citizen science project.
Use advisory boards and workgroups	Create and engage a formal group of multiple kinds of stakeholders to provide input and advice on the citizen science project and to elicit recommendations for improvements.
Use an engagement advisor	Seek guidance from experts in engagement of stakeholders for citizen science projects.
Use data experts	Involve, hire, and/or consult experts to inform management on the use of data generated by citizen science.
Use digital storytelling	Use storytelling as a way to let citizens and stakeholders share experiences and create a sense of belonging between stakeholders and citizens.
Use existing communication channels	Promoting and informing citizens and other stakeholders through already existing communication channels. These channels can be internal to the university (college) or research institution, or they can be channels of external partners.
Use existing networks	Use existing networks and communities to engage your target audience.
Use mass media	Use media to reach large numbers of people to spread the word about the citizen science project.
Use gamification	Adding gaming elements (e.g. rewards, competitions, challenges, …) to your citizen science project.
Use organizations (in your network) as intermediaries	Use organizations that you're already well-connected to as intermediaries to reach your target audience.
Use other payment schemes	Introduce payment approaches that make it easy for stakeholders and citizens to use the innovation related to the citizen science project.
Use social media	Use social media as a way to inform participants, interact with citizens and stakeholders, bring your citizen science project to live and keep participants engaged.
Use the snowball sampling method	Ask your target audience and stakeholders to identify and attract new participants from their personal network.
Use train-the-trainer strategies	Train designated stakeholders or organizations to train others in the innovation related to the citizen science project.

5.1.7. Conclusions

Based on a literature review of strategies identified in previous research as being important for implementation science (Powell et al., 2015) and recommendations by Scivil, the Flemish

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knowledge centre on citizen science (Veeckman et al., 2019), 52 possible engagement strategies were identified as the starting point of the Delphi process. After three feedback rounds by citizen science experts, 48 engagement strategies and their definitions were retained. In line with the implementation strategies proposed by Powell and colleagues (2015), this list of engagement strategies is intended to indicate the potential range of engagement strategies that can be used in a citizen science project. It is not intended as a checklist where all strategies need to be used at all times. Depending on the goal of the project and resource constraints, researchers working on a citizen science project can choose the engagement strategies that they see most fit.

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6 Barriers and best practices

6.1. Podcasts

Podcast interviews with Citizen Science experts involved conducting two in-depth structured podcast interviews with individuals coming from each partner university who possess specialized knowledge, expertise, or experience in the Citizen Science area or was involved in a Citizen Science project as a participant, citizen or project leader.

The methodology followed a semi-structured approach, UCLL as WP5 lead provided a methodical and technical guide called 'Guide to create a podcast' to navigate all partner institutions throughout data collection method by podcasts, which was for some partners relatively new, in order to create a uniformity in all episodes of the podcasts. The guide discusses some characteristics and use of podcasts and a playbook to record a successful podcast. To make sure each partner institution started from the same base and to create uniformity in all 12 episodes (2 podcasts per institution) a flexible script was foreseen. The guide also foresaw technical support to create the most optimal environment for recording a podcast if the institution lacked a professional recording studio.

The podcasts' script allowed for both predefined questions and open-ended discussions. Experts were selected in each partner university by the WP5 team based on their position in the university, qualifications, expertise, and relevance to the Citizen Science topic. Interviews were conducted through a podcast interview, always face-to-face by the WP5 teams, supported by the most professional infrastructure available at that time in each institution. Every institution had the option, which the flexible podcast script provided, to carry out interviews either individually with one person or in a panel discussion format. However, the interviews consistently followed a structured approach, with each participant offering insights relevant to their area of expertise. The interview questions allowed for the experts' insights, perspectives, and opinions, aiming to gather rich qualitative data. To allow for an inclusive sampling procedure, some participants conducted the interview in their native language if they didn't feel comfortable in English.

The content of the podcast interviews brought up such diverse themes that each institute individually did the analysis. Each institution formulated its own best practices and barriers for Citizen Science thematically by the key themes, which emerged from the podcast interviews providing valuable insights, management and expert knowledge on Citizen Science at each partner university.

Based on these podcast interviews each partner has contributed to gain further knowledge in barriers and best practices that are experienced by experts, experts by experience and participants in citizen science projects. Different insights came from different university departments with different levels of access or information on Citizen Science and were synthesized by the WP5 team

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from each university and delivered as one single structured report based on expert interviews through podcasts.

6.1.1. Results from Vidzemes Augstskola (ViA), Latvia

ViA Institutional Situation

Challenges and best practices from ViA collected from ongoing and completed research projects in citizen science refer to projects representing different fields – biology, geography, social sciences, arts, computer science, social work etc. ViA citizen science projects have practices with a very limited number of participants who have done a large amount of work, as well as practices with several hundred participants but less depth of involvement.

When developing citizen science projects, quite a few project organizers have been inspired by participatory research and action research.

ViA has yet to establish a regular practice of implementing citizen science projects and so far, citizen engagement is rather inconsistent. At the same time, there are CS projects where empowerment of people lies at the very base of these projects and that involve hard-to-reach target groups. Quite a few projects have engaged target groups that are easier to reach such as university students, high school students, teachers.

Citizen scientist groups engaged in citizen science projects of ViA.

Project 1	Disadvantaged groups – young mothers with no education or very low levels of education, mothers with three or more children, Roma women – mothers, people with disabilities, including young people with disabilities; families with family members with disabilities or long-term illnesses (oncology); pre-retirement age women with neuropsychiatric disorders.
Project 2	Residents of Latvia, university students, students' family members – elders, people with practical knowledge in park maintenance, farmers.
Project 3	Local entrepreneurs, other local and regional tourism related organizations and stakeholders, state institutions (nature parks etc.), tourism related NGOs, local inhabitants, students.
Project 4	Mostly schoolteachers but also some university-level instructors.
Project 5	University and secondary school students of performing arts, visual arts and culture.

Engagement methods of target groups in citizen science projects

The widest spectrum of engagement methods has been used in projects engaging socially vulnerable targets groups. Participatory research design consisted of both formal and informal methods; to mention a few:

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- Informal methods (kitchen talk, informal activities, life history method) to facilitate conversation, built trust, establish personal relationship and also collect data.
- Participatory appraisal method – a broad empowerment approach that seeks to build community knowledge and encourage participants. It uses a lot of visual methods which is significant when target group members might have low education, experience of isolation, complex past etc.
- Problem tree in the combination with eco-system approach – to encourage participants to analyse their problems & solutions.
- Design thinking – to create and evaluate product ideas for social entrepreneurship activities.
- Roundtable of democracy etc.
- Games to encourage individuals to express their thoughts.
- Presentations
- Discussions etc.

The institution also has experience in engaging citizen participants in a wide spectrum of workshop-based activities where participants contribute in different ways (including data analysis and interpretation). In cases where larger participation has been involved in the project, digital communication channels have been used to promote project activities. Thus, one example of citizen science activity invited people to observe surrounding landscape and search for photo-evidence how it has changed over time, to identify and describe transformed elements of the landscape. In this process, participants increased their awareness about rural landscapes, its transformations, economic significance etc. The activity proved to be very successful and around 400 participants took part in rural landscape observations.

The methods used in CS projects contributed to data collection, observation activities, in some cases data analysis and interpretation and also solving complex problems.

Challenges faced by project organizers during project implementation

Several project organizers reported participant recruitment as a significant challenge, and it took a lot of time and effort to overcome it. Specifically, it was the case of landscape observation activity where organizers aimed to recruit hundreds of people and also in the case of socially vulnerable groups. Project organizers did not report problems when aiming to recruit students, school pupils, teachers, representatives from state and municipal institutions, NGOs.

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Researchers also refer to the insufficient resources and pressure of time as barriers to engagement – they would like to engage target groups more, but, for example, each extra round of workshops takes time.

CS project analysis in ViA presents specific challenges to recruit and sustain two target groups – entrepreneurs and socially vulnerable people. In case of businesspeople the most challenging is to convince people that their engagement makes sense, it is meaningful, and will bring value for their business. Community gains or benefits in the long term cannot always serve as effective arguments from the perspective of entrepreneur. It has been more challenging to engage larger successful businesses. The motivation to partially engage is dependent on the strengths of local community ties. If there is an established practice of networking, gatherings of local businesses, it is easier to recruit participants.

It is more likely that rewards will increase recruitment among young people. Sometimes when attempting to sustain the interest of young people, researchers struggle to provide innovative ways.

As already mentioned, in the case of socially vulnerable people, a lot of effort should be made to recruit participants and to train them as they might lack previous experience of engagement in specific activities, there can be issues of trust, confidence etc. In cases like this, it is harder to follow the project plan (e.g., schedule) and adjustments can be needed.

One aspect to consider is the follow-up activities after the citizen science project is completed. For example, if business owners have been involved in planning local development, it is *important that afterwards there is communication with these stakeholders – if the organization should make some changes, how new development plans would impact business. The follow-up is important also, keeping in mind future citizen science projects as it would help to make sense of their participation. Yet sometimes these activities are omitted from the project.*

Benefits for participants and institution

Regarding citizen science projects, institutions report different type of benefits. Project organizers have reported that citizen participants have carried out activities which researchers would not be able to perform due to insufficient resources, e.g., in the case of landscape observation activities, people have collected data on hundreds of landscaped, which a small group of scientists would not be able to do. Engagement of citizen participants have contributed to the quality of the project outcome – the projects implemented by researchers frequently aim to improve situation of local communities, some groups and these groups most efficiently can identify their needs and evaluate if the proposed activities are appropriate. The institution also benefits from strengthened network with local community, businesses etc.

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Regarding the benefits for the participants, some projects have contributed to decreased social isolation of people, and improved economic situation. In all cases, projects have educational value for citizens as they have gained new knowledge and ability to trigger people's interest to explore new fields. Another social benefit is that the common theme brings together people from different generations and contributes to the transfer of knowledge. In some cases, when projects are aimed to improve the situation of the local community and other groups, they benefit from output in different ways (e.g., improved learning environment, business environment etc.).

6.1.2. Results from Fachhochschule St Pölten GMBH (STPUAS), Austria

STPUAS Institutional situation

St. Pölten University of Applied Sciences has first experiences with citizen science approaches in different research fields (social sciences, media technology, circular economy). As STPUAS is a university of applied sciences and describes itself as engaged university, the interaction with civil society, businesses and policy makers are relevant elements of its academic work. The number of researchers with specific expertise in conducting citizen science projects is still comparatively low, however the interest of engaging in citizen science project is rising. This higher interest is mainly driven by two aspects:

- Personal interest: The personal interest of individual researchers is still one key motivation for developing and conducting citizen science projects.
- Funding opportunities: The region of Lower Austria is very much pushing research projects with focus on citizen science. The main aim of the local government in funding citizen science activities is to overcome the growing scepticism towards science. The funding of the Lower Austrian Research Funding Agency (GFF) already offered top-up fundings for project with citizen science aspects. Since 2023, a specific open-topic call for citizen science projects was launched, with high interest of participation of STPUAS' researchers. Furthermore, individual research and funding organization, e.g., Ludwig Boltzmann Gesellschaft have opened smaller calls for developing and conducting citizen science projects.

The evolvement of citizen science activities at STPUAS is also driven by its long history in collaborating with civil society, business and policy makers. Whereas citizens were often used as test subjects in the past, their role has now evolved into that of equal researchers.

Citizen scientist groups engaged in citizen science projects of STPUAS:

- People with impairments (physical, psychological, cognitive or speech)
- Marginally underrepresented groups
- Students, media creators, wood workers

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- Local civil society

Citizens were mainly involved in data collection, observation, co-identifying research questions, creating and refining project design and co-developing technologies and applications.

Challenges faced by project organizers during project implementation

Researchers reported that main challenges in implementing citizen science projects can mainly be identified in recruiting the citizen scientists. People were contacted but they did not react. Or they reacted at first but after some time there was no further response. It is hard to keep in touch with them and engage them on a longer period of time. Projects with topics related to health and privacy have an even harder time because of the sensitive data. Same goes for projects which want to involve schools and pupils. In addition to that, the renumeration for citizen scientists poses bureaucratic difficulties for the administration due to tax and social security regulation.

Furthermore, the different “languages” are also a challenge.

Benefits for participants and institutions

Researchers reported that main benefits to involve citizens as scientists in research activities is that they know best what the problems are as they belong to the relevant group. Issues were revealed that the researchers were not aware of. The involved citizens had much larger knowledge about the problems and issues.

6.1.3. Results from Magyar Agrár - és Élettudományi Egyetem (MATE), Hungary

MATE Institutional Situation

Research topic (ID)	Related disciplines	Group involved	Research activity of group involved
Measurement of food waste in households in Kaposvár (MATE1)	Social Sciences, Management, Economics, Statistics	Households in Kaposvár	Measurement, feedback, participation in awareness raising programme
Time management research at work (MATE2)	Management, Statistics, Psychology	Employees of agricultural enterprises	Keeping a time diary (measurement), cooperation in the creation of a workflow map
Establishment and complex study of agroforestry sample farms (MATE3)	Agricultural Sciences, Economics, Management, Meteorology, Process Informatics, Statistics	Small farmers, family farms	The managers of the sample farms designed and developed the systems under study themselves, planned the location and positioning of the test instruments (soil probes, met stations) themselves. The data measured by the instruments were processed by the university researchers, who then wrote scientific journal articles and conference papers, partly in collaboration with the farmers. The collaboration also included

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Research topic (ID)	Related disciplines	Group involved	Research activity of group involved
			two study visits to one of the sample farms by university researchers.
Preparation of a workshop study and a collection of case studies on sustainable development of the Tab district based on local assets/resources (MATE4)	Rural Development, Regional Economics, Economics, Agricultural Sciences, Environmental Economics	NGO: Völgyhangja Association; Local experts, farmers and local decision-makers	A leading role in data collection, data collation and analysis for the studies was fulfilled by an NGO, bringing together local stakeholders. The studies were written jointly by university staff and volunteers from the association.
Highlight the importance of career education for the younger population as well (MATE5)	Social Sciences, Pedagogy	Parents, kindergarten teachers	observation of children's behaviour, conducting scientific experiments; Diary keeping

What were the benefits of doing a transdisciplinary study?

All of the above cases fit the definition of transdisciplinary research. The researchers leading the research had to go beyond their own disciplinary boundaries and involve civil society participants in their research organisation, in most cases already at the design stage, in order to be successful.

In each case, the key motivation for involvement was to understand the natural-socio-economic problem system in more depth and detail than ever before, and through the perspective of the real stakeholders. In the majority of cases, the involvement of NGOs has already contributed significantly to the understanding and definition of the research problem.

What were the challenges of doing a transdisciplinary study?

In the case of MATE1, the biggest challenge was the preparation, preparation and methodological soundness of the households. In addition, the data collection methodology had to be both simple and scientifically sound and usable.

The main difficulty in MATE2 was the recruitment and motivation of staff at the workplace. In many cases, members of the target group often felt that keeping a work diary was an unnecessary waste of time. A separate discussion had to be held to clarify the benefits they could expect from the time diary at work.

At MATE3, there were many cases where research and economic and technological considerations of importance to farmers clashed during the design of the sample farms and the installation of the measuring instruments. Reconciling and coordinating these required several rounds of discussions, joint field visits and mutual compromises.

MATE4 was the least challenging. The research objective and the NGO's local development vision complemented and supported each other well. Perhaps a challenge was that the NGO practitioners

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would have envisaged a significantly larger project requiring more research resources. Nevertheless, a common voice and plan was quickly found.

MATE5 the biggest challenge was to find parents and kindergarten teachers to participate because they all lacked the time.

What was the goal of choosing citizen science approach?

The aim was the same as described above: to understand the nature and causes of the problems at the focus of the research in more depth and at the most elementary level possible. This could only be done by involving and training civilians in the research. In addition, the aim was also to involve participants in awareness-raising/local economic development activities during and/or after the active research phase, in order to achieve real social impact and change.

Are there research fields that you think are related to citizen science which you draw inspiration from?

In all four cases, the concept of participatory research was the main inspiration. The reasons for this are explained above.

In addition, in MATE3 and MATE4, the concept of implementation research was also a key driver. In both cases, the challenge of testing, evaluating, designing and improving the practical adaptability of systems, technologies and good practices already available at international level to local conditions in the field was very exciting.

How did you engage citizens?

In all cases, involvement was based on volunteering and the intrinsic motivation of those involved. The driving force was a shared interest and set of values (MATE1) and a common socio-economic interest (MATE3, MATE4). In the case of MATE2, it has to be admitted that in the first instance, entrepreneurs and employers were recruited for the research, and they helped to involve employees. But in the latter case, we placed great emphasis on making the final decisions of the employees voluntary.

In neither case were financial or material incentives used. A short abstract of the research results was given to the civil participants after the research, and in the case of MATE3 and 4, the results were presented and discussed in a joint workshop.
In the case of MATE3 and 4, we were also encouraged by the provision of free real-time access to the measurement results, the expert and advisory service provided by the university and the possibility of future joint grant projects.

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Was there a role for the project in opening science?

In part, yes. In the case of MATE1, the methodology, results and main conclusions of the research were published in a public and free journal of a sustainability association and on the association's website in a clear and accessible way.

For MATE3, we published the practical results of the research and the strategy for the dissemination of agroforestry in Hungary in a public document on the website of the research project.

In MATE4, a workshop paper and a case study booklet were produced and handed over to the partner NGO and participating NGOs.

Are there other aspects which you find relevant?

For MATE3, we encountered a specific problem in two cases. The soil probes placed in the sample farms were damaged and destroyed during the mechanical soil works, immediately in the first year of the study and at the beginning of the second year. We had to learn how to "bomb-proof" and mark these expensive instruments buried in the soil, so that we did not lose any more to tractor work. Asset protection (theft from the field) was the biggest problem with the micro-meteorological stations, and great care was needed to place the equipment. The farmers involved often forgot to do the basic maintenance tasks in the first year, they had them redone every year.

6.1.4. Results from Instituto Politécnico de Setúbal (IPS), Portugal

IPS Institutional Situation

In Portugal, at IPS, we already have some development in citizen science projects, but there is still a lot to do. In any case, we present projects in different areas (Medicine and Health, Environmental Sciences, Biology, Genetics and Biotechnology. Nature conservation and Ecology, Applied Sciences, Engineering and Technology and Social Sciences) with diverse populations and with different thematic areas, involving local institutions, members of local communities, parents' associations, patient associations, universities of applied sciences, companies and users' associations.

Two of these projects served as the basis for the elaboration of the podcast and the other three, the researchers were participants in the Delphi rounds.

IPS Institutional Data collection through podcasts

At IPS, two podcasts were held where two researchers who have ongoing citizen science projects were interviewed, one in the area of biodiversity and the other in the area of health and well-being.

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In the first podcast, José Sousa, researcher and professor at IPS, who leads the "*IPS ComVida"* (IPS WithLife) project, was interviewed and explained that this is a project that aims to involve the community in biodiversity monitoring and foster awareness for the importance of biodiversity and the preservation of this type of natural habitats. It is developed along the 22 acres in Setúbal camp and 5 acres in Barreiro camp, with a typically Mediterranean habitats, and the citizen scientists are the IPS staff, students and the local community. The first objective is collecting data, with species inventory, because knowledge is the best tool to create the big picture about the state of this habitats. How to maintain the flow of incoming data and how to engage people in this project, were the first obstacles encountered, so the team decided to use the Biodiversity4All platform, that is linked to iNaturalist, and is a well-known tool in the naturalist Portuguese community. Here, two projects were created, one for Setúbal and another for Barreiro, and there were developed some activities to help disseminate this project, from environmental education activities for IPS students, children and teenagers from local schools, an itinerant photo exhibition with different species of plants, reptiles, insects, birds, etc., and also a Biodiversity Station at Setúbal and a BioSpot in Barreiro, with boards that contain information about the observed species. With all the efforts in engaging citizen scientists, the project have more than 3000 records in Biodiversity4All. During the conversation it was clear that it is necessary to disseminate citizen science to the public and that is possible for everyone to actively participate in research projects. Besides that, it's necessary to find an interface or intermediaries to mediate the relationship between the researchers and the public, in shortening the gap that still exist between scientist and public, and to encounter an equal language that is comfortable for both parts.

The second interview was with Ana Lúcia Ramos, researcher and professor at IPS, with interests related to the empowerment of the citizens, especially the children and their families. The project that was discussed in this podcast was "The Parental Stress and Perceived Social Support Project: Integrated Perspectives and Approaches in Extreme Situations", with primary carers of children up to the age of 3, and it is divided into two main phases. The first step was to describe and analyze the risk factors and protective factors of parental well-being, analyze parental stress as a risk factor and analyze the psychosocial profile of families. The second phase, which is the one that is being developed at the moment and which is also more related to citizen science, aims to discuss the social support needs perceived by families with nurses from health units and parents of children up to the age of 3 and propose an integrated approach to increase the factors that protect well-being and reduce the risk factors for parental well-being with nurses and parents. During the development of the project, it was identified the difficulty of maintaining the families engaged. The study's first phase consisted of online questionnaires and the team had nearly 1,000 responses, which is quite a good number. However, when the parents were invited to attend an online session where the

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general data was going to be presented, the response was much lower. Likewise, when the team asked parents about strategies to help families cope with parental stress, the answers were fewer and more diverse than they wanted. The project team tried to face this, by continuing to work with the people and trying to captivate them and attract others. Ana concluded with the observation that citizen science is also somewhat complex, and it requires a paradigm shift in some researchers and, above all, communication, communication between science and society.

6.1.5. Results from Universitatea Politehnica Timișoara (UPT), Romania

UPT Institutional Situation

UPT identified several citizen science projects inside de university, but also in the community. Two were documented through podcasts and the other through written interviews. Citizen science was applied in projects from various domains, such as computer science, architecture, management, cultural heritage, or smart city. Most project leaders have applied citizen science techniques without knowing that they are called like this. A lot of university members that we surveyed in search of citizen science cases have declared that they did not involve citizens in their projects so far (outside of plain collection of feedback) but are interested in making concrete steps in this direction.

At the moment, there is no policy at the institutional level regarding citizen science projects in the Politehnica University of Timisoara.

Several types of citizen scientists have been engaged in projects at UPT:

Project 1	residents of Jimbolia, university students
Project 2	university students
Project 3	local community interested in the cultural heritage of Timisoara, disadvantaged groups, university students, high school students
Project 4	citizens, civil society representatives
Project 5	citizens living or working in Timisoara

These citizen scientists were engaged in activities such as: data collection, observation, co-designing investigations, co-developing technologies and applications, analysing data, interpreting the results of data, or perpetuating the best practices promoted by the project.

Several strategies for engaging them were identified, such as: conducting local needs assessment, conducting local consensus discussions, adjusting communication to target group, assessing engagement barriers and facilitators, making inclusive project design choices, obtaining and using feedback from citizens and other stakeholders, organizing regular stakeholder meetings, providing incentives, and using existing communication channels / existing networks / digital storytelling / mass media.

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UPT Institutional Data collection through podcasts

UPT produced two podcasts featuring project leaders from two distinct areas. The first podcast was with Stefana Badescu, from the Faculty of Architecture and Urban Planning, who managed a project consisting in designing an action plan for heritage valorisation in the town of Jimbolia, very close to Timisoara.

In this project, Stefana engaged students, the future architects, and the local community (representatives and citizens) as citizen scientists. They were engaged in gathering data and verifying it with the stakeholders, as well as in analysing it, running workshops, and writing the action plan.

The second podcast featured Stelian Nicola, from the Faculty of Automation and Computers, who led a project called VisitUPT consisting in creating a VR application for virtually visiting the university facilities and discovering the teachers and courses.

Stelian involved master students from the Faculty of Automation and Computers to co-create and implement the application and students from the Faculty of Architecture and Urban Planning to design the 3D models. Other students tested the application and gathered feedback.

Engagement methods of target groups in citizen science projects

To engage the citizen scientists, UPT project leaders used various approaches. Stefana organized the students' visit to Jimbolia so that they could reach as many local citizens as possible, to tell them about the action plan and try to convince them to join the project. A lot of workshops were organized with the local administration, NGOs, cultural institutions, economic development entities, followed by structured discussions with the citizens to verify the conclusions from the workshops, and public presentations of the intermediary and final results. Everyone felt engaged because they were put at the same table and because the project organizers were very active, very present in the community.

The communication was so good that the organizers had the surprise of being contacted by the secondary school in Jimbolia, who heard about the project and showed interest in contributing. As a result, several events were organized with the teachers and the pupils.

The students were engaged through weekly meetings, to get feedback on their tasks, to realign and discuss tasks for the next period.

For the Visit UPT project, Stelian engaged the master students through paid opportunities, such as scholarships, but also through non-paid opportunities, such as those to work with new technology like Oculus VR glasses, to gain practical experience and to receive feedback from experienced

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developers. Also, the usage of free, open-source tools to create VR applications and to collaborate further motivated these students.

Challenges faced by project organizers during project implementation

One of the biggest challenges faced by Stefana was that the larger community of Jimbolia didn't look at the project organizers with trust in the beginning. This happened because citizens have been approached in the past to contribute to various projects that did not bring any benefit to them and of which they did not hear anything about afterwards. Stefana and her colleagues benefited from the fact that they came from a well-known university and that they kept a steady presence in the community, but also because they were introduced to the larger community by the local representatives (City Hall etc.).

Stelian also faced challenges in regard to motivating students to respect all the deadlines of the project, since developers and 3D creators needed to synchronize their work very carefully. He managed to overcome such challenges by communicating frequently with the students and explaining the importance of their work.

Benefits for participants and institution

Stefana concluded that several benefits emerged from having this citizen science component in her project. Firstly, involving the community makes the citizens more aware of their surroundings, of what is happening around them. Simple citizens become engines of local development by giving them a voice. The project gave birth to a very popular online publication, the Jimboblog, of which the city is very proud.

Involving the students also had its benefits. This act contributes to the formation of future architects through such informal learning methods. This was the conclusion that Stelian also reached, regarding the formation of future computer scientists.

Engaging volunteers significantly reduces the costs associated with data collection, analysis, and fieldwork, enabling institutions to stretch their research budgets further.

The successful projects can generate positive publicity and showcase the institution's commitment to community engagement and scientific research. The data and findings can influence environmental policies and conservation efforts, benefiting the organization's advocacy and mission.

Participants gain educational, personal, and community benefits while institutions and organizations benefit from cost-effective research, extensive data collection, and enhanced public engagement.

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6.1.6. UC Limburg (UCLL), Belgium

UCLL Institutional Situation

At UCLL, we have several citizen science studies running related to different research topics, such as creating inclusive societies, investigating air quality, digital design, intrafamilial violence and mental wellbeing. Five case studies were identified in UCLL, of which three were used for input during the Delphi rounds and two were used for the podcasts.

UCLL Institutional Data collection through podcasts

At UCLL two interviews with Citizen Science experts were conducted, both experts were researchers in citizen science projects.

The first interview was conducted in English, the expert was a researcher in a Citizen Science project to measure air quality in the classroom. The citizen scientists in the project were minors and their teacher who acted as an intermediary. Since the minors were already familiar with their teacher, they acted as an accessible contact person. Throughout the interview the pivotal role that **intermediaries** play, particularly for certain target groups such as minors, emerged. Intermediaries, acting as facilitators between the scientific community and citizens, play a crucial role in bridging gaps and creating a conducive environment for participation. When it comes to minors, these intermediaries often include educators, parents, or community leaders who guide and support young participants throughout the scientific process. Their role is not just to convey information but to inspire curiosity, provide necessary guidance, and ensure a safe and enriching experience for the younger contributors. **Consistent communication** emerges as a second essential for maintaining citizen involvement in Citizen Science projects. Clear and ongoing communication fosters a sense of community, keeps participants informed about project progress, and reinforces the importance of their contributions. This is especially critical for minors, as regular updates and feedback help maintain their interest and enthusiasm. Consistent communication however requires the most important project resource, namely ‘time investment’. So even before the beginning of the Citizen Science project, the allocation of resources for the communication time with project participants should be well addressed and planned.

The second expert at UCLL was interviewed in Dutch. The expert was the project leader in a Citizen Science project ‘Online care for specials’. The project brochure gives an overview of a number of websites, tools, apps ... aimed at persons with intellectual disabilities. This selection was made on the basis of conversations with caregivers and clients. They are therefore tools around themes that are perceived as very important by experts by experience and are a combination of information tools, support applications, chat and email functions. To embed **inclusivity** in its fullest form, two persons with intellectual disability were recruited at UCLL and worked as equivalent **co-**

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researchers in the research team while conducting the Citizen Science project. The two newly recruits were involved in every step of the research such as question drafting, taking surveys, organizing focus group discussions, participating in dissemination moments like encounter days.

A second Citizen Science project this citizen science expert participated in was called ‘Senior for support’. This Citizen Science project investigates whether the digital 'Sense of Belonging' among seniors can be increased by strengthening their digital skills. To this end, UCLL has developed a peer-to-peer training program ("the S4S pathway") using a participatory process in co-creation with a few ambassadors (seniors). These ambassadors offer the S4S trajectory to other seniors to strengthen their digital skills and contribute to a higher digital 'Sense of Belonging'. Although there was no limitation for the seniors as co-designers they were not involved as co-researcher like in the first project. The **seniors were ambassadors** and had a role in giving training to other seniors who wanted to develop digital skills.

The citizen science expert highlights these two Citizen Science projects have **different levels of participatio**n for participants. Do you want to give the participants just advisory or testing roles or do you involve them as researchers? In the second case, they should conduct research tasks, and this involves a lot. Before the beginning of the project, it should be very clear at what level a researcher wants participation and inclusive work. Preconditions should always be met so there is no sham participation.

Especially when you try to work as inclusive as possible, with participants as co-researchers, then the **division of roles** should be very clear. Ensuring inclusiveness and engagement presents some serious challenges. As the researcher has often already taken a lot of steps in the preliminary study before the experience expert is involved, one has to keep in mind that complete inclusiveness cannot be achieved. Sometimes an expert through experience wants to take on the role of project leader, and in doing so they may have different outcomes of the study in mind than the researcher, who has often been busy researching literature for several years prior to the field study. The complete inclusiveness of also appointing a citizen as project leader complementary to the researcher in citizen science projects may lead to role conflicts. The citizen science expert tells us that not being clear in the beginning about the division of roles between researcher and project leader can cause problems that compromise the continuity of the research.

An experience expert has completely different competencies than a researcher so working in a complementary way will let the research reach a higher level. Citizen science projects, which involve the collaboration of the general public in scientific research, rely on the active participation of diverse individuals. This also asks for more clarity around **remuneration framework**, so that

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there is ongoing motivation of all participants, especially if we expect as much from participants as from the researcher.

Inclusiveness, a key pillar of citizen science, is inherently challenging due to factors such as age, socioeconomic background, and educational disparities. Experts stress the need for tailored strategies to break down barriers and make scientific participation accessible to a wide range of individuals. For minors, this might involve developing age-appropriate materials, creating educational programs, and establishing partnerships with schools to integrate citizen science into curricula.

In conclusion, the success of Citizen Science in the above projects, conducted by researchers of UCLL hinges on recognizing the significance of intermediaries, particularly for some target groups like minors or underprivileged and disadvantaged people. Through mindful inclusiveness, clear and consistent communication, participants stay involved and are aware of their contribution to the Citizen Science Project. This involves quite some flexibility, effort and time investment of the researcher as project leader, that needs to actively seek feedback from participants, refining strategies based on experience, and being open to evolving methodologies to better meet the needs of diverse contributors. Rethinking the reward system to ensure long-term involvement of participants in citizen science projects is essential in further success of this qualitative research method with endless possibilities.

6.2. Dissemination Podcasts

In total all six institutions recorded two podcasts with citizen science experts, who participated in or led a research project in this qualitative research method.

All episodes of our project's podcast *Citizen Science Chronicles by Ent-r-e-novators* can be accessed through our official website for comprehensive dissemination. The podcasts, thoughtfully curated to articulate the nuances of our initiatives, are available on a dedicated section of our project website: https://www.entrenovators.eu/

The website serves as a centralized platform for an auditory experience, providing a nuanced perspective on our work and to gain a profound understanding of our project through the informative medium of podcasting. By navigating to this website one can explore a collection of twelve insightful episodes featuring in-depth discussions, expert interviews, and inspiring narratives of citizen science experts. Collected by the researchers working on this European project, all episodes illuminate the core of our project.

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7 Conclusion and discussion

In conclusion, this guide serves as a comprehensive resource for researchers in the field of citizen science. Citizen science, defined by its core principles of public participation, collaboration, and the pursuit of scientific knowledge, empowers individuals to actively engage in scientific research, extending the boundaries of traditional research. The guide explores various models of engagement, aligning projects with defined goals and objectives. It emphasizes the significance of recognizing different levels of engagement and how to effectively define target groups, catering to diverse perspectives and increasing inclusivity of citizen science projects.

Engagement strategies are presented to guide researchers in maximizing engagement of each target group, while ethical considerations ensure the responsible conduct of citizen science projects. Data quality assurance and long-term sustainability underline the need for rigor and lasting impact. The Delphi study with citizen science experts provides a comprehensive overview of possible engagement strategies researchers can use in citizen science research.

Barriers and best practices were identified, based on the experience from citizen science experts in the six research institutions. This guide, therefore, equips researchers with the knowledge and tools to design inclusive and impactful citizen science projects that foster collaboration, enhance data quality, and drive scientific innovation. It is our hope that researchers, armed with this insight, will continue to advance the frontiers of citizen science, engage communities, and contribute to positive societal change.

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9 Annexes

Annex 1: Survey for round 1 of the Delphi study

E³UDRES² Ent-R-E-Novators

Creating engagement models for citizen science

Introduction

E³UDRES² Ent-R-E-novators aims to create a joint Research and Innovation hub across six European Higher Education Institutions. The ambition is to have a strong interconnection between education, innovation, research and entrepreneurship departing from regional needs. To reach this goal, Ent-R-E-novators will create an engagement model guide.

About the survey

In order to create an engagement model guide, we need input from citizen science experts like you!

This questionnaire is part of a Delphi study consisting of three rounds. The first two rounds will be online questionnaire, while the last round will be a 90-minute online consensus meeting.

When you participate in the Delphi study, you will get the opportunity to co-author any scientific publication resulting from the Delphi study, and you will receive the engagement models guide resulting from the Delphi study.

In this survey, you will see a number of discrete engagement strategies along with their definitions. For the purposes of this exercise, discrete engagement strategies are defined as single actions or processes that may be used to engage citizens or other stakeholders to participate in citizen science. The discrete engagement strategies listed below were taken from two sources, 1) strategies used in implementation science (Powell et al., 2015) and 2) recommendations by Scivil, the Flemish knowledge center on citizen science (Veeckman et al., 2019).

Powell, B. J., Waltz, T. J., Chinman, M. J., Damschroder, L. J., Smith, J. L., Matthieu, M. M., ... & Kirchner, J. E. (2015). A refined compilation of implementation strategies: results from the Expert Recommendations for Implementing Change (ERIC) project. Implementation science, 10(1), 1-14.

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Before reviewing these terms, take a moment and think of all the citizen science projects with which you are most familiar. Taking all of these experiences into consideration, please review the list of discrete engagement strategies below.

If a listed strategy is very similar to other strategies (by a different name) with which you are familiar, please enter the names of the similar strategy(ies) in the “Synonyms” text box. If you have any additional thoughts or concerns regarding the definition provided for a given engagement strategy (e.g., specificity, breadth, or deviation from a familiar source), please type those comments into the “Comments” text box.

The survey's distributor, University College Leuven - Limburg hereby declares that no personal data are collected and that collected data and responses are treated in a strictly confidential manner. The gathered information could be utilized for creating an engagement models guide and a scientific publication. If you have any questions about the data collection, you can contact Sarah De Coninck (sarah.deconinck@ucll.be).

Please indicate that you accept our Terms and declaration of non-disclosure:

Adjust communication to target group

Create separate communication plans if you want to engage different target audiences (e.g. formal or informal tone, how to approach target audience, generic or specific or individual approach, …).

Synonyms:

Comments:

Alter patient/consumer fees

Create fee structures where patients/consumers pay less for preferred treatments or products (the ones being researched) and more for less-preferred treatments or products.

Synonyms:

Comments:

Assess engagement barriers and facilitators

Assess various factors that facilitate or hinder stakeholder and citizen engagement.

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Synonyms:

Comments:

Assess initial and continued motivation for participation

Make an assessment of the facilitators and barriers that influence motivation to participate in the project and differentiate between factors influencing initial participation and continued participation.

Synonyms:

Comments:

Audit and provide feedback

Collect and summarize data concerning stakeholder engagement over a specified time period and use it to monitor, evaluate, and modify engagement strategies throughout the project.

Synonyms:

Comments:

Build a coalition

Recruit and cultivate relationships with partners in the citizen science project.

Synonyms:

Comments:

Centralize technical assistance

Develop and use a centralized system to deliver technical assistance focused on issues related to the citizen science project.

Synonyms:

Comments:

Conduct educational meetings

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Hold meetings targeted toward different stakeholder groups (e.g., providers, administrators, other organizational stakeholders, community, citizens, patient/consumer, family stakeholders, …) to teach them about the citizen science project.

Synonyms:

Comments:

Conduct educational outreach visits

Have a trained person meet with citizens and other stakeholders with the intent of changing their behavior and/or engagement to the citizen science project.

Synonyms:

Comments:

Conduct local consensus discussions

Include citizens and other stakeholders in discussions that address whether the chosen problem is important and whether the intervention and/or citizen science project to address it is appropriate.

Synonyms:

Comments:

Conduct local needs assessment

Consult with your target audience(s) to adjust your perception of them, identify their needs, wishes, requirements and barriers, and alter your engagement strategy and citizen science project accordingly.

Synonyms:

Comments:

Conduct ongoing training

Plan for and conduct training in the citizen science project in an ongoing way.

Synonyms:

Comments:

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Create a learning collaborative

Facilitate the formation of groups of citizens or other stakeholder and foster a collaborative learning environment to improve engagement to the citizen science project.

Synonyms:

Comments:

Create new intervention teams

Change who serves on the clinical team, adding different disciplines and different skills to make it more likely that the clinical innovation is delivered (or is more successfully delivered).

Synonyms:

Comments:

Define the level of engagement from different target groups

Define the level of engagement that you want from different target groups (e.g. citizens, organisations, family groups, other stakeholders, …). Split your audiences into primary, secondary and intermediary target audiences.

Synonyms:

Comments:

Define the stakeholders and their roles

Define the stakeholders that you need in your citizen science project and the role they will have in the project. When defining your target audience, you can consider the following: size, age, gender, level of education, prior knowledge of the research subject, initial interest, engagement with the subject and your organization, ...

Synonyms:

Comments:

Develop and implement tools for quality monitoring

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Develop, test, and introduce into quality-monitoring systems the right input—the appropriate language, protocols, algorithms, standards, and measures (of processes, behavioral outcomes, implementation outcomes and engagement outcomes) that are often specific to the citizen science project.

Synonyms:

Comments:

Develop disincentives

Provide (financial) disincentives for failure to engage with the citizen science project.

Synonyms:

Comments:

Develop educational materials

Develop and format manuals, toolkits, and other supporting materials in ways that make it easier for stakeholders and citizens to learn about the citizen science project and (if applicable) for organizations to learn how to deliver the intervention.

Synonyms:

Comments:

Distribute educational materials

Distribute educational materials (including guidelines, manuals, and toolkits) in person, by mail, and/or electronically

Synonyms:

Comments:

Evaluate engagement indicators

Measure and evaluate indicators of engagement from citizens and other stakeholders after the project.

Synonyms:

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Comments:

Identify project ambassadors

Identify citizen scientist or stakeholders who can be ambassadors for the project. Ambassadors have been involved since the very beginning of the citizen science project, know a lot about your project's research topic and have a strong intrinsic motivation to participate.

Synonyms:

Comments:

Intervene with citizens and other stakeholders to enhance uptake and adherence to the citizen science protocol

Develop strategies with citizens and other stakeholders to encourage and problem solve around adherence to the study protocol.

Synonyms:

Comments:

Make inclusive project design choices

Adjusting your citizen science project design and engagement strategies to include specific target groups (e.g. such as at-risk groups).

Synonyms:

Comments:

Make training dynamic

Vary the information delivery methods to cater to different learning styles and work contexts, and shape the training in the citizen science project to be interactive.

Synonyms:

Comments:

Obtain and use feedback from citizens and other stakeholders

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Develop strategies to increase feedback from citizens and other stakeholders on the citizen science project and how it is implemented.

Synonyms:

Comments:

Obtain formal commitments

Obtain written commitments from key partners that state how they will be engaged in the citizen science project.

Synonyms:

Comments:

Organize fun and social activities

Organize activities where education about the citizen science project is combined with fun and social activities.

Synonyms:

Comments:

Organize regular stakeholder meetings

Introduce regular opportunities for contact in which you highlight once again the project aims, its benefits to the community and (interim) research results.

Synonyms:

Comments:

Prepare citizens to be active participants

Prepare citizens to be active in the citizen science project, to ask questions, and specifically to inquire about guidelines concerning the project, the evidence behind decisions, or about available evidence-supported interventions.

Synonyms:

Comments:

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Promote adaptability

Identify the ways a citizen science project can be tailored to meet local needs and clarify which elements of the project must be maintained to preserve fidelity (e.g. the degree to which the project is delivered as intended) to the project.

Synonyms:

Comments:

Provide supervision

Provide stakeholders who will provide the innovation with ongoing supervision. Provide training for supervisors who will supervise stakeholders who provide the innovation.

Synonyms:

Comments:

Provide incentives

Provide incentives or rewards as an extrinsic motivation for citizens and stakeholders to participate in the citizen science project.

Synonyms:

Comments:

Provide local technical assistance

Develop and use a system to deliver technical assistance focused on issues related to the citizen science project using local personnel.

Synonyms:

Comments:

Provide ongoing consultation

Provide ongoing consultation with one or more experts in the strategies used to support the implementation of the citizen science project.

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Synonyms:

Comments:

Purposely reexamine the implementation of the citizen science project

Monitor progress and adjust the citizen science project and implementation strategies to continuously improve the quality of the project.

Synonyms:

Comments:

Recruit, designate, and train for leadership

Recruit, designate, and train leaders for implementation of the citizen science project.

Synonyms:

Comments:

Remind stakeholders

Develop reminder systems designed to help stakeholders to recall information and/or prompt them to use the citizen science project.

Synonyms:

Comments:

Tailor strategies

Tailor the implementation of the citizen science project to address barriers and leverage facilitators that were identified through earlier data collection.

Synonyms:

Comments:

Use advisory boards and workgroups

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Create and engage a formal group of multiple kinds of stakeholders to provide input and advice on the citizen science project and to elicit recommendations for improvements.

Synonyms:

Comments:

Use an engagement advisor

Seek guidance from experts in engagement of stakeholders for citizen science projects.

Synonyms:

Comments:

Use data experts

Involve, hire, and/or consult experts to inform management on the use of data generated by citizen science.

Synonyms:

Comments:

Use existing communication channels

Promoting and informing citizens and other stakeholders through already existing communication channels. These channels can be internal to the university (college) or research institution, or they can be channels of external partners.

Synonyms:

Comments:

Use digital storytelling

Use storytelling as a way to let citizens and stakeholders share experiences and create a sense of belonging between stakeholders and citizens.

Synonyms:

Comments:

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Use existing networks

Use existing networks and communities to engage your target audience.

Synonyms:

Comments:

Use gamification

Adding gaming elements (e.g. rewards, competitions, challenges, …) to your citizen science project.

Synonyms:

Comments:

Use mass media

Use media to reach large numbers of people to spread the word about the citizen science project.

Synonyms:

Comments:

Use organizations (in your network) as intermediaries

Use organizations that you're already well-connected to as intermediaries to reach your target audience.

Synonyms:

Comments:

Use other payment schemes

Introduce payment approaches that make it easy for stakeholders and citizens to use the innovation related to the citizen science project.

Synonyms:

Comments:

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Use social media

Use social media as a way to inform participants, interact with citizens and stakeholders, bring your citizen science project to live and keep participants engaged.

Synonyms:

Comments:

Use the snowball sampling method

Ask your target audience and stakeholders to identify and attract new participants from their personal network.

Synonyms:

Comments:

Use train-the-trainer strategies

Train designated stakeholders or organizations to train others in the innovation related to the citizen science project.

Synonyms:

Comments:

Are there any other stakeholder or citizen engagement strategies that you can think of?

Do you have anything else you would like to share?

☐ I want to be informed of the results of this study

☐ I want to be involved in a scientific publication based on the Delphi study

☐ (if yes to any of the above) Please provide your e-mail address so we can contact you. This is solely used for the purpose of keeping you informed about the results and the scientific publication and will not be shared with any third parties.

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Annex 2: Round 2 of the Delphi study

E³UDRES² Ent-R-E-Novators: Creating engagement models for citizens and stakeholders

Welcome to the E³UDRES² Ent-R-E-Novators: Creating engagement models for citizens and stakeholders Delphi Round 2. We would like to thank everyone who participated in Round 1. In Round 1, the text only described the core definition. In Round 2, potential additional explanatory information based on the comments from Round 1 is presented separate from the core definition. Our aim is that the core definitions will be fixed by the end of the Delphi activities. Explanatory material is intended to be more fluid. However, comments on explanatory material are still welcome in Round 2. In Round 2, the strategies are organized by section based on the types of feedback received in Round 1. An overview of the sections is provided below. Section 1: Terms with comments about the core definition. This section contains strategies where respondents provided alternate definitions or other content. Section 2: Terms with comments about the core definition without an alternative provided. This section contains strategies where respondents noted possible difficulties with the core definition but no alternate definitions were proposed. Section 3: Duplicates. This section contains strategies that respondents noted were very overlapping with others. Section 4: New strategies. This section contains additional strategies indicated by respondents. Section 5: Terms with comments relating to explanatory material. This section contains strategies that received comments relating to explanatory material. No changes to the core definition were suggested. Section 6: Terms with no comments. This section contains strategies where none of the comments suggested changes to the core definition or explanatory material. Terms in sections 1 – 3 will likely be targeted for voting in the consensus webinar.

*1. The survey's distributor, University College Leuven - Limburg hereby declares that no personal data are collected and that collected data and responses are treated in a strictly confidential manner. The gathered information could be utilized for creating an engagement models guide and a scientific publication. If you have any questions about the data collection, you can contact Sarah De Coninck (sarah.deconinck@ucll.be). Please indicate that you accept our Terms and declaration of non-disclosure:

- ☐ I accept the terms and declaration of non-disclosure
- ☐ I do not accept the terms and declaration of non-disclosure

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Section 1: Terms with comments about the core definition

Comments to these terms involved suggestions for alternative definitions. This is your opportunity to make further comments or alternate definition suggestions regarding these strategies prior to the consensus webinar where voting will occur. If you feel an alternative definition for the strategy is warranted, propose one in the respective comment box or endorse one of the alternate (ALT) definitions that are listed below the strategy's Round 1 summary by using the comment box. If you feel the original definition for the strategy is adequate, you can leave the respective comment box empty. Contributions to explanatory material are welcome but not necessary.

Adjust communication to target group

Create separate communication plans if you want to engage different target audiences (e.g. formal or informal tone, how to approach target audience, generic or specific or individual approach, …).

Synonyms:

- Communication strategy
- Segmentation
- Adapting Communication Styles to Different Audiences
- Diverse communication strategy
- Personalize communication to target group
- Dart-model: 'Dialogue'

Core definition comments:

- More attention needs to be given to the practical implementation of the communication plan by incorporating a plan that addresses specific barriers to communication encountered by different groups, as well as the facilitators that can help overcome them.

Accessory material comments:

- An empathy map could be a useful tool to develop a specific plan
- e.g. different languages, simple language, according to the target group you want to reach
- It is crucial to use the relevant channels: tiktok, instagram for youngsters, facebook for older and local communication is local places (kindergarten, ngo's)

ALT: Create separate communication plans if you want to engage different target audiences (e.g. formal or informal tone, how to approach target audience, generic or specific or individual approach, …), incorporating both barriers and facilitators to communication encountered by different groups.

Adjust communication to target group - Comments:

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Alter patient/consumer fees

Create fee structures where patients/consumers pay less for preferred treatments or products (the ones being researched) and more for less-preferred treatments or products

Synonyms:

- Pricing models that incentivize participants
- DART-model: 'Access'
- Pricing strategy
- Incentives
- Modify fees for patient/consumer
- Revise patient/consumer costs
- Customize charges for patients/clients

Core definition comments:

- I propose a generalization of the description, extending it to a sector-neutral approach.

Accessory material comments:

- When we involve citizen scientist (social work research) or experts by experience, we pay them an expense allowance or a salary if they are participating for a longer period.
- Changing services for free, voluntary jobs, involve school kids, parents

ALT: Create fee structures where participants pay less for preferred interventions or products (the ones being researched) and more for less-preferred interventions or products

Alter patient/consumer fees - Comments:

Conduct ongoing training

Plan for and conduct training in the citizen science project in an ongoing way

Synonyms:

- Organize ongoing training
- Planning and implementation

Core definition comments:

- To ensure that participants have the necessary knowledge and skills to contribute effectively
- Too vague
- Extend it with personal mentoring and coaching

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- Also trainings for citizen scientists for example in research methods

Accessory material comments:

- Use it as an incentive
- With local trainers, no outsider teachers

ALT: Plan for and conduct training and personal coaching in the citizen science project to ensure that participants and citizen scientist have the necessary knowledge and skills to contribute effectively to the project in an ongoing way

Conduct ongoing training - Comments

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Section 2: Terms with comments about the core definition without an alternative provided.

These are terms where some respondents indicated difficulties with the core definition such as it being too vague. The comments were not specific enough to propose an alternate definition for the strategy. This is your opportunity to make further comments or alternate definition suggestions regarding these strategies prior to the consensus webinar where voting will occur. If you feel an alternative definition for the strategy is warranted, propose one in the respective comment box. If you feel the original definition for the strategy is adequate, you can leave the respective comment box empty. Contributions to explanatory material are welcome but not necessary.

Assess engagement barriers and facilitators

Assess various factors that facilitate or hinder stakeholder and citizen engagement.

Synonyms:

- Needs assessment DART-model: 'Risk reduction'
- Evaluation method
- Stakeholder map
- Evaluate engagement barriers and facilitators

Core definition comments:

- It would be desirable to clarify the categories and possible types of various factors in the description.

Accessory material comments:

- Facilitating: Is there clear communication, is the project accessible, what is the relevance for the participant? Is the collected data and aim transparent, is there trust built? Are there any recognition/rewards? Maybe there can even be simultaneous community building? Barriers: lack of awareness of the benefits of the project too complex, no resources, lack of feedback loop, bureaucracy (too much admin), exclusivity, Community values.

Assess engagement barriers and facilitators - Comments:

Build a coalition

Recruit and cultivate relationships with partners in the citizen science project

Synonyms:

- Partner strategy
- Collaborate with stakeholders and partners
- Relationship-management
- Network-management.
- Cooperation

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- Develop a community
- Community building, third mission
- Build an alliance
- Local Partnerships

Core definition comments

- Could be more detailed. What does a 'coalition' mean? You are already partners in the project.
- Better to emphasize complex and holistic networking and network management

Accessory material comments:

- Develop a 'partner strategy' (e.g. common understanding of the mission, building trust, roles & responsibilities, planning, ...)
- Informal events, leisure activities
- Forge partnerships with local businesses, schools, libraries, or community centres to serve as hubs for project-related activities and information dissemination

Build a coalition - Comments:

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Section 3: Duplicates

Comments to these terms suggested that they were very similar to other strategies. This is your opportunity to make further comments to the core definition or suggest which of the similar strategies should be kept in the final list, prior to the consensus webinar where voting will occur. If you feel the term overlaps with one of the other strategies (a list of the strategies can be found below), please indicate all the strategies that you feel overlap with the term. Additionally, indicate whether you think all terms should be in the final list, or whether one of the terms – and if so which one – should be withheld in the final list. Contributions to explanatory material are welcome but not necessary.

List of engagement strategies:

Adjust communication to target group
Alter patient/consumer fees
Art and Science Collaborations
Assess engagement barriers and facilitators
Assess initial and continued motivation for participation
Audit and provide feedback
Build a coalition
Centralize technical assistance
Citizen Science Apps
Collaborative Art Installations
Conduct educational meetings
Conduct educational outreach visits
Conduct local consensus discussions
Conduct local needs assessment
Conduct ongoing training
Create a learning collaborative
Create new intervention teams
Define the level of engagement from different target groups
Define the stakeholders and their roles
Develop and implement tools for quality monitoring
Develop disincentives
Develop educational materials
Distribute educational materials
Evaluate engagement indicators
Identify project ambassadors

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Intervene with citizens and other stakeholders to enhance uptake and adherence to the citizen science protocol
Make inclusive project design choices
Make training dynamic
Obtain formal commitments
Obtain and use feedback from citizens and other stakeholders
Organize fun and social activities
Organize regular stakeholder meetings
Prepare citizens to be active participants
Promote adaptability
Provide incentives
Provide local technical assistance
Provide ongoing consultation
Provide supervision
Purposely reexamine the implementation of the citizen science project
Recruit, designate, and train for leadership
Remind stakeholders
Tailor strategies
Use advisory boards and workgroups
Use an engagement advisor
Use data experts
Use digital storytelling
Use existing communication channels
Use existing networks
Use mass media
Use organizations (in your network) as intermediaries
Use other payment schemes
Use social media
Use train-the-trainer strategies
Use the snowball sampling method
Use gamification.

Assess initial and continued motivation for participation

Make an assessment of the facilitators and barriers that influence motivation to participate in the project and differentiate between factors influencing initial participation and continued participation.

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Synonyms:

- Relation-management
- Evaluate initial and continued motivation for participation

Core definition comments:

- I think it could be merged with 'Assess engagement barriers and facilitators'

Accessory material comments:

- what keeps them engaged throughout its duration, while also identifying any obstacles or barriers that might discourage participation. This information can be valuable for project planners and managers in tailoring strategies to attract and retain participants effectively.
- To participate: Interest or curiosity about the scientific inquiry - community involvement and low thresholds to participate or enter. - Clear purpose and transparency - what's in it for me?
- To continue participation: - be part of community - feedback - be aware of impact (lack of updates is killing involvement) - recognition/ reward - avoid repetition (boring, especially for youngsters)

Assess initial and continued motivation for participation - Comments:

Develop and implement tools for quality monitoring

Develop, test, and introduce into quality-monitoring systems the right input—the appropriate language, protocols, algorithms, standards, and measures (of processes, behavioural outcomes, implementation outcomes and engagement outcomes) that are often specific to the citizen science project

Synonyms:

- Design and implement tools for quality monitoring
- Design the monitoring and evaluation plan

Core definition comments:

- Duplicated strategy (very similar to several strategic items above)

Accessory material comments:

- First understand what you aim to achieve, both in terms of scientific research and community engagement so you can identify some metrics (KPI).

Develop and implement tools for quality monitoring - Comments:

Evaluate engagement indicators

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Measure and evaluate indicators of engagement from citizens and other stakeholders after the project.

Synonyms:

- Assess engagement indicators
- Community sustainability
- Assess citizen and stakeholder engagement post-project.
- Performance Management
- Analyse engagement parameters

Core definition comments:

- Same with 'Audit and provide feedback'

Accessory material comments:

- Baseline data is often forgotten. I prefer focus groups instead of surveys involvement and usefull feedback is higher.
- With interviews

Evaluate engagement indicators - Comments:

Obtain and use feedback from citizens and other stakeholders

Develop strategies to increase feedback from citizens and other stakeholders on the citizen science project and how it is implemented

Synonyms:

- Create feedback loops from stakeholders
- Feedback loops
- Get and use feedback from citizens and other stakeholders

Core definition comments:

- Duplicated... very similar strategies above

Accessory material comments:

- Facebook groups, local boxes with paper and pencils, brainstorming
- Make sure they can give you feedback easily (accessibility). Formal and informal survey
- anonymous option

Obtain and use feedback from citizens and other stakeholders - Comments:

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Organize regular stakeholder meetings

Introduce regular opportunities for contact in which you highlight once again the project aims, its benefits to the community and (interim) research results.

Synonyms:

Core definition comments:

- Duplicated, a very similar strategy can be found above.

Accessory material comments:

- Communication --> transparency --> involvement loop
- Local and cultural events

Organize regular stakeholder meetings - Comments:

Prepare citizens to be active participants

Prepare citizens to be active in the citizen science project, to ask questions, and specifically to inquire about guidelines concerning the project, the evidence behind decisions, or about available evidence-supported interventions

Synonyms:

- Engage citizens to be active participants
- Invite citizens to be active participants

Core definition comments:

- Duplicated, very similar strategies can be found above.

Accessory material comments:

- Education and training
- Give clarity about expectations but also create curiosity

Prepare citizens to be active participants - Comments:

Promote adaptability

Identify the ways a citizen science project can be tailored to meet local needs and clarify which elements of the project must be maintained to preserve fidelity (e.g. the degree to which the project is delivered as intended) to the project

Synonyms:

- Be flexible while guarding project quality

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Core definition comments:

- Duplicated, very similar strategies can be found above.

Accessory material comments:

- Brainstorming, interview

Promote adaptability - Comments:

Provide local technical assistance

Develop and use a system to deliver technical assistance focused on issues related to the citizen science project using local personnel

Synonyms:

- Give local technical assistance
- Knowledge transfer implementation

Core definition comments:

- Same with 'Centralize technical assistance'- Duplicated, very similar strategies can be found above. Accessory material comments:

14. Provide local technical assistance - Comments:

Provide ongoing consultation Provide ongoing consultation with one or more experts in the strategies used to support the implementation of the citizen science project Synonyms: - Give ongoing consultation Core definition comments: - Duplicated, very similar strategies can be found above. Accessory material comments:

15. Provide ongoing consultation - Comments:

Tailor strategies Tailor the implementation of the citizen science project to address barriers and leverage facilitators that were identified through earlier data collection Synonyms: Core definition comments: - Duplicated, very similar strategies can be found above. Accessory material comments:

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16. Tailor strategies - Comments:

Use existing networks Use existing networks and communities to engage your target audience. Synonyms: Core definition comments: - Same with 'Use existing communication channels' Accessory material comments:

17. Use existing networks - Comments:

Section 4: New strategies

The following strategies were proposed as additional discrete implementation strategies. Proposed strategies were retained if they did not overlap with strategies already in the list. If you feel an alternative definition for the strategy is warranted, propose one in the respective comment box. If you feel the original definition for the strategy is adequate, you can leave the respective comment box empty. Contributions to explanatory material are welcome but not necessary.

Art and Science Collaborations Partner with artists and creative individuals to create art-science collaborations that communicate project findings.

18. Art and Science Collaborations - Comments:

Citizen Science Apps Develop mobile apps that allow citizens to contribute data or participate in activities related to your project conveniently.

19. Citizen Science Apps - Comments:

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Collaborative Art Installations Create collaborative art installations that visually represent project data and engage the community in the artistic process.

20. Collaborative Art Installations - Comments:

. Section 5: Terms with comments relating to explanatory material.

If respondents commented on these strategies in Round 1, the comments were not clearly about changing the core definition. This is your opportunity to make comments or alternate definition suggestions regarding these strategies prior to the consensus webinar where voting will occur. If you feel an alternative definition for the strategy is warranted, propose one in the respective comment box. If you feel the original definition for the strategy is adequate, you can leave the respective comment box empty. Contributions to explanatory material are welcome but not necessary.

Audit and provide feedback Collect and summarize data concerning stakeholder engagement over a specified time period and use it to monitor, evaluate, and modify engagement strategies throughout the project. Synonyms: - Monitoring and evaluating- DART-model: 'Transparency'- Evaluation and co-production- Iterative cycle of assessment and improvement- Examine and provide feedback Core definition comments: Accessory material comments: - Discuss the data together with citizen scientist- You will need a clear outline of the metrics and KPI that you will use to measure stakeholder engagement (e.g. number of participants, response rate, ..) and how to collect it (interviews, surveys, ...) For student involvement we even evaluate the effectiveness of our engagement strategies, so we often have to modify our strategies.

21. Audit and provide feedback - Comments:

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Centralize technical assistance Develop and use a centralized system to deliver technical assistance focused on issues related to the citizen science project Synonyms:- Experience building- Technical support- Consolidate technical assistance Core definition comments: Accessory material comments:- What kind of system? IT System? Management System? Risk management System? Decision Supporting System? etc.- Define the scope and objective, first you yourself should understand what the specific issues and challenges participants may face so you know what resources you will need. Best to use a centralizes platform with some FAQ.

22. Centralize technical assistance - Comments:

Conduct educational meetings Hold meetings targeted toward different stakeholder groups (e.g., providers, administrators, other organizational stakeholders, community, citizens, patient/consumer, family stakeholders, …) to teach them about the citizen science project Synonyms:- Educational workshops- Training - Mentoring- Steering group- Coach the coaches.- Organize educational meetings- Public Workshops- Interactive Workshops Core definition comments: Accessory material comments:- Connected to leisure activities, school programmes- Project steering group (project leaders, experts by experience, researchers), operational group (experts by experience, researchers), advisory board with experts and workshops (other citizen scientists, researchers, possibily one project leader)- It certainly helps to have the support (involvement) of all stakeholders. If targeted you can tailor your outreach so it becomes easier to highlight the value and objective for the different groups. - Host workshops or training sessions open to the public to educate citizens about the project's goals, methods, and how they can get involved.- Offer interactive workshops that engage participants in data analysis, interpretation, and storytelling related to project outcomes.

23. Conduct educational meetings - Comments:

Conduct educational outreach visits Have a trained person meet with citizens and other stakeholders with the intent of changing their behaviour and/or engagement to the citizen science project Synonyms:- Organize educational outreach visits- Impact management- Active

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recruitment of participants- A skilled communicator Core definition comments: Accessory material comments:- This trained person could be a citizen scientist or an expert by experience.- This trained person should be a well-known person with high social skills, wide local network

24. Conduct educational outreach visits - Comments:

Conduct local consensus discussions Include citizens and other stakeholders in discussions that address whether the chosen problem is important and whether the intervention and/or citizen science project to address it is appropriate Synonyms: - Organize local consensus discussions- Facilitation workshops- Focus groups, future workshops- Socialization- Build Community Consensus- Cocreate new solutions- Community-Based Research Core definition comments: Accessory material comments:- Ensuring that the project aligns with community needs and concerns - transparent communication - group discussions (community) - is the project ethical? - sense of ownership- Engage community organizations or local groups in conducting research that aligns with your project's objectives.

25. Conduct local consensus discussions - Comments:

Conduct local needs assessment Consult with your target audience(s) to adjust your perception of them, identify their needs, wishes, requirements and barriers, and alter your engagement strategy and citizen science project accordingly. Synonyms: - Run local needs assessment- Participatory research design- Community Surveys Core definition comments: Accessory material comments: - Surveys are less effective, group interview have more opportunity to get relevant, daily needs- Conduct surveys within the community to gather input, preferences, and feedback, and use the results to shape project activities.

26. Conduct local needs assessment - Comments:

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Create a learning collaborative Facilitate the formation of groups of citizens or other stakeholder and foster a collaborative learning environment to improve engagement to the citizen science project Synonyms: - Organize a learning collaborative- Community building- Co-creation Core definition comments: Accessory material comments: - Include local ngo's

27. Create a learning collaborative - Comments:

Create new intervention teams Change who serves on the clinical team, adding different disciplines and different skills to make it more likely that the clinical innovation is delivered (or is more successfully delivered) Synonyms: - Multidisciplinary intervention teams- Establish new intervention teams Core definition comments: Accessory material comments: - Leverage a wider range of expertise and perspectives.

28. Create new intervention teams - Comments:

Define the level of engagement from different target groups Define the level of engagement that you want from different target groups (e.g. citizens, organisations, family groups, other stakeholders, …). Split your audiences into primary, secondary and intermediary target audiences. Synonyms: - Segmentation- Extensive stakeholder map Core definition comments: Accessory material comments: - Use the basic market segmentation approach and tools.

29. Define the level of engagement from different target groups - Comments:

Define the stakeholders and their roles Define the stakeholders that you need in your citizen science project and the role they will have in the project. When defining your target audience, you can consider the following: size, age, gender, level of education, prior knowledge of the research

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subject, initial interest, engagement with the subject and your organization, ...Synonyms:- Determine the stakeholders and their roles Core definition comments: Accessory material comments:- (and intermediary like the project coordinators, educators and facilitators e.g.)- You could work with core citizen scientists (experts by experience who are involved over the whole project duration) and citizen scientists (other experts by experience, local stakeholders, family members who are involved only once or twice during the project)- Communication should be relevant to the specific group of people,

30. Define the stakeholders and their roles - Comments:

Develop educational materials Develop and format manuals, toolkits, and other supporting materials in ways that make it easier for stakeholders and citizens to learn about the citizen science project and (if applicable) for organizations to learn how to deliver the intervention. Synonyms: - Dissemination- Create educational materials Core definition comments: Accessory material comments: - Online and offline

31. Develop educational materials - Comments:

Distribute educational materials Distribute educational materials (including guidelines, manuals, and toolkits) in person, by mail, and/or electronically Synonyms: - Share educational materials- Open knowledge- Share educational materials in person, by mail, or digitally. Core definition comments: Accessory material comments:- Online and offline

32. Distribute educational materials - Comments:

Identify project ambassadors Identify citizen scientist or stakeholders who can be ambassadors for the project. Ambassadors have been involved since the very beginning of the

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citizen science project, know a lot about your project's research topic and have a strong intrinsic motivation to participate. Synonyms: - Establish project ambassadors- Multiplicators- Identify and activate project ambassadors Core definition comments: Accessory material comments:- Importance of intrinsic motivation and good communication skills- Use well-known local organisations and schools

33. Identify project ambassadors - Comments:

Intervene with citizens and other stakeholders to enhance uptake and adherence to the citizen science protocol Develop strategies with citizens and other stakeholders to encourage and problem solve around adherence to the study protocol Synonyms: - Involve citizens and other stakeholders to enhance uptake and adherence to the citizen science protocol Core definition comments: Accessory material comments: - Maintain transparent and accessible communication so participants can foster a sense of ownership to the protocol

34. Intervene with citizens and other stakeholders to enhance uptake and adherence to the citizen science protocol - Comments:

Make inclusive project design choices Adjusting your citizen science project design and engagement strategies to include specific target groups (e.g. such as at-risk groups).Synonyms:- Create inclusive project design choices- User centred research design- Participatory research design- address a diverse target group- Inclusivity Initiative- Multilingual Outreach Core definition comments: Accessory material comments:- Get a better understanding of barriers and facilitators for different subgroups- Implement strategies to ensure that underrepresented groups and communities have equal access and opportunities to engage in the project- Ensure that project materials, communications, and engagement opportunities are accessible in multiple languages to reach diverse communities.

35. Make inclusive project design choices - Comments:

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Obtain formal commitments Obtain written commitments from key partners that state how they will be engaged in the citizen science project Synonyms: - Write down commitments form partners- Consent form- Receive formal commitments Core definition comments: Accessory material comments: - Ensure clear expectations and accountability

36. Obtain formal commitments - Comments:

Organize fun and social activities Organize activities where education about the citizen science project is combined with fun and social activities. Synonyms: - Create a group vibe- Gamification- Team building- Create fun and social activities- Citizen Science Events- Community Science Festivals Core definition comments: Accessory material comments:- Involve kindergarten, schools, parents, elderly homes- Address this task to a person in the very beginning and make a timeline- Organize citizen science events, such as science fairs, hackathons, or data collection challenges, to bring participants together for collaborative activities.- Organize science festivals or events within the community, where citizens can actively participate in hands-on scientific activities.

37. Organize fun and social activities - Comments:

Provide supervision Provide stakeholders who will provide the innovation with ongoing supervision. Provide training for supervisors who will supervise stakeholders who provide the innovation Synonyms: - Coaching, mentoring- Supervise innovation providers and train their supervisors. - Train the trainer Core definition comments: Accessory material comments: - Clearly define roles and expectations- Regular meeting (monthly, quarterly) for stakeholders with supervisors

38. Provide supervision - Comments:

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Provide incentives Provide incentives or rewards as an extrinsic motivation for citizens and stakeholders to participate in the citizen science project. Synonyms: - Offer rewards- Provide incentives/benefits- Incentive Programs Core definition comments: Accessory material comments: - Incentives can take many different forms (like in the form of 'training', access to the platform/ innovation/ .. be part of the network/ community ...)- Non-material rewards and advantages- Leisure time, sport equipment, - Implement incentive programs that reward citizens and stakeholders for their contributions, such as gift cards, certificates, or recognition.

39. Provide incentives - Comments:

Purposely reexamine the implementation of the citizen science project Monitor progress and adjust the citizen science project and implementation strategies to continuously improve the quality of the project Synonyms: - With intent reexamine the implementation of the citizen science project Core definition comments: Accessory material comments:- PDCA process is necessary if only to keep involvement- Regularly (e.g. quarterly)

40. Purposely reexamine the implementation of the citizen science project - Comments:

Recruit, designate, and train for leadership Recruit, designate, and train leaders for implementation of the citizen science project Synonyms: - Train-the-trainer Core definition comments: Accessory material comments:- From local people

41. Recruit, designate, and train for leadership - Comments:

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Remind stakeholders Develop reminder systems designed to help stakeholders to recall information and/or prompt them to use the citizen science project Synonyms: - Keep the information flow going Core definition comments: Accessory material comments: - You might need some technical support if you work with an app

42. Remind stakeholders - Comments:

Use advisory boards and workgroups

Create and engage a formal group of multiple kinds of stakeholders to provide input and advice on the citizen science project and to elicit recommendations for improvements

Synonyms:

- Community Advisory Boards

Core definition comments:

Accessory material comments:- Agenda setting is essential to have repetitive communication- Advisory board consisting of different experts (experts by experience, social worker, stakeholder, mental health professionals). - Should have experience in relevant projects- Establish community advisory boards or councils to provide ongoing input and guidance on project decisions and priorities.

43. Use advisory boards and workgroups - Comments:

Use an engagement advisor

Seek guidance from experts in engagement of stakeholders for citizen science projects

Synonyms

- Mentoring System
- Find professional support for your campaign

Core definition comments:

Accessory material comments:

- Should have experience in relevant projects

44. Use an engagement advisor - Comments:

Use existing communication channels

Promoting and informing citizens and other stakeholders through already existing communication channels. These channels can be internal to the university (college) or research institution, or they can be channels of external partners.

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Synonyms:

Core definition comments:

Accessory material comments:

- Try to keep communication low threshold. Also give the possibility to call or text, especially for people who are digitally illiterate.

45. Use existing communication channels - Comments:

Use digital storytelling

Use storytelling as a way to let citizens and stakeholders share experiences and create a sense of belonging between stakeholders and citizens.

Synonyms:

- Narrating
- Storytelling Workshops

Core definition comments:

Accessory material comments:

- Create events for this
- Also offer an analogue possibility.
- It gives a sense of belonging, but do not make it an extra task, we use the communication window for this, e.g. : we start the meeting with sharing some stories or experiences of the last couple of weeks
- Conduct storytelling workshops that teach participants how to share their experiences and discoveries related to the project.

46. Use digital storytelling - Comments:

Use mass media

Use media to reach large numbers of people to spread the word about the citizen science project

Synonyms:

- Press work
- Local Media Engagement

Core definition comments:

Accessory material comments:

- Local media has more effect on local projects
- Collaborate with local media outlets, newspapers, and radio stations to share project updates and stories with a broader audience.

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47. Use mass media - Comments:

Use organizations (in your network) as intermediaries

Use organizations that you're already well-connected to as intermediaries to reach your target audience.

Synonyms

- Use organizations (in your network) as brokers

Core definition comments:

Accessory material comments:

- Make use of partnerships

48. Use organizations (in your network) as intermediaries - Comments:

Use social media

Use social media as a way to inform participants, interact with citizens and stakeholders, bring your citizen science project to live and keep participants engaged.

Synonyms:

- Public Talks and Webinars
- Social Media Campaigns

Core definition comments:

Accessory material comments:

- Adapt to target group (youngsters Instagram/ TikTok older people: Facebook)
- Relevant apps for different age groups
- Arrange public talks or webinars featuring project experts, scientists, or guest speakers to share insights and findings with the community.
- Launch targeted social media campaigns to raise awareness, recruit participants, and encourage discussion around project topics.

49. Use social media - Comments:

Use the snowball sampling method

Ask your target audience and stakeholders to identify and attract new participants from their personal network.

Synonyms:

- Use chain sampling method
- Peer-to-Peer Engagement

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Core definition comments:

Accessory material comments:

- Follow up if you want this to work.
- Encourage participants to recruit friends, family members, or colleagues to join the project, fostering a sense of community and social connections.

50. Use the snowball sampling method - Comments:

Use gamification

Adding gaming elements (e.g. rewards, competitions, challenges, …) to your citizen science project.

Synonyms:

- Gamified Education

Core definition comments:

Accessory material comments:

- Develop educational games or apps that teach citizens about the scientific concepts and methodologies used in the project.

51. Use gamification - Comments:

Section 6: Terms with no comments.

Respondents indicated no comments regarding these strategies. This is your opportunity to make further comments or alternate definition suggestions regarding these strategies prior to the consensus webinar where voting will occur. If you feel an alternative definition for the strategy is warranted, propose one in the respective comment box. If you feel the original definition for the strategy is adequate, you can leave the respective comment box empty. Contributions to explanatory material are welcome but not necessary.

Develop disincentives

Provide (financial) disincentives for failure to engage with the citizen science project

Synonyms:

- Impose penalties for not participating in the citizen science project.

Core definition comments:

Accessory material comments:

52. Develop disincentives - Comments:

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Make training dynamic

Vary the information delivery methods to cater to different learning styles and work contexts, and shape the training in the citizen science project to be interactive

Synonyms:

- Use interactive training methods
- Agile learning and teaching environment
- Make training interactive

Core definition comments:

Accessory material comments:

53. Make training dynamic - Comments:

Use data experts

Involve, hire, and/or consult experts to inform management on the use of data generated by citizen science

Synonyms:

- Third party resources.

Core definition comments:

Accessory material comments:

54. Use data experts - Comments:

Use other payment schemes

Introduce payment approaches that make it easy for stakeholders and citizens to use the innovation related to the citizen science project

Synonyms:

- Fair science
- Make participation affordable

Core definition comments:

Accessory material comments:

55. Use other payment schemes - Comments:

Use train-the-trainer strategies

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Train designated stakeholders or organizations to train others in the innovation related to the citizen science project

Synonyms:

- Shared knowledge

Core definition comments:

Accessory material comments:

56. Use train-the-trainer strategies - Comments

57. Do you have anything else you would like to share?

58. Please provide your e-mail address if you want to be informed of the results of the study or you want to be involved in a publication based on the Delphi study. This is solely used for the purpose of keeping you informed about the results and the scientific publication and will not be shared with any third parties.

Your responses have been registered! Thank you for taking the time to complete the survey, your input is valuable to us.

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Annex 3: Voting guide for the Delphi webinar

Citizen Science Engagement Strategies

Voting Guide

In this webinar you will be voting on suggested modifications to the discrete engagement strategies included in the Delphi study of the entrenovators project. We will have 7 strategies to vote on. Many of these votes may be easy decisions, while others will be more difficult. To support the voting process a separate “Voting Notes” file is provided that presents the label for the strategy and all proposed definitions for voting. It also contains columns where you can record your vote in advance of the meeting. This is for your personal use to help keep the voting process. We want to be able to efficiently record consensus for strategies where consensus comes easy so that there will be adequate time to discuss terms with low consensus. If possible, it helps to have your votes for the approval poll prepared in the ”Voting Notes” file before entering the webinar.

The webinar will last AT LEAST 60 Minutes and if possible, please allow up to 90 minutes in your schedule in case discussion results in an extended webinar. If possible, try to enter the webinar 5 minutes in advance. We will start on time.

What is the Focus of the Voting Process?

Voting focuses on characterizing consensus regarding the definition of discrete engagement strategies. Discrete engagement strategies are defined as single actions or processes that may be used to engage citizens or other stakeholders to participate in citizen science.

Two sources were the inspiration for the engagement strategies included in the first 2 rounds, namely, 1) strategies used in implementation science (Powell et al., 2015) and 2) recommendations by Scivil, the Flemish knowledge centre on citizen science (Veeckman et al., 2019).

Only strategies with alternative definitions are included in the voting process (total = 7). The figure to the right provides an overview of the voting process.

What are the Specifics of the Voting Process?

The webinar will utilize online polling to characterize consensus for the strategies’ definitions.

- Approval Polling: in approval polling you are free to endorse ALL of the definitions you find acceptable for a strategy. The first poll for each strategy will be an approval poll.
  - If one definition receives ≥60% approval (and is not tied with another) then that definition is declared the winner and will be retained.

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o If there is no ≥60% winner in the approval poll, there will be a discussion period (see below) followed by runoff polling.

• Runoff polling: in runoff polling you can only endorse one voting alternative.

o If there are only two choices, then the definition receiving the most votes will be retained for the rest of the process.

o If there are three or more choices, there will be two rounds.

 Round 1 identifies the top two definitions for the strategy

 Round 2: the definition receiving the most votes will be retained.

How are Discussions Structured?

Discussions only occur after an approval poll fails to identify a clear winner with ≥60% approval or a tie. If a tie involves definitions with ≥60% approval, then only those definitions ≥60% are open for discussion. Discussions are limited to 5 minutes total for each strategy due to time limitations. The moderator will ask panellists interested in contributing to the discussion to "raise their hand" in the webinar. You raise your hand by clicking on the hand button in Teams. When you are called upon to comment, unmute your phone and try to limit your comments to 60 seconds or less to provide adequate time for other participants to make comments. If someone makes a comment that is similar to the one you planned on making, then please consider "un-raising" your hand by clicking on the hand icon again. When there are no additional hands raised or the 5-minute discussion time has expired, the webinar will return to runoff voting as described above. Note, given the structured voting process used in this project, the question box will not be monitored or used, even though it will be visible to you.

• Constructive discussion is anticipated to focus on the relative merits of the proposed definitional alternatives or the needs of an adequate definition.

• Remember: issues of related evidence and practicality/feasibility are beyond the scope of obtaining consensus on the definitions. Wordsmithing or editing for clarity of speech or grammar can be suggested via an email as long as the suggestion does not substantively change the meaning of the definition.

• Accessory materials: Some of the feedback that we received in the modified Delphi surveys will be included in accessory material rather than in the definition and therefor may not appear in the alternative definitions.

How was Vote-able Material Determined?

Participant comments from the earlier modified Delphi survey rounds were categorized as either a) concerning the core definition, b) concerning accessory material to the definition, or c) editorial comments.

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a) Some core definition comments included a complete proposal for an alternative definition while some described concerns or minor modifications. Suggestions that improved the grammar or readability of the definition were adopted based on investigative team consensus that the change did not alter the core meaning of the definition. When the investigative team had concerns that minor modifications may significantly change the meaning or emphasis of a strategy, an alternative definition was constructed to present the change to expert panel members.

b) Accessory material is intended to be more fluid and accommodate additional guidance and examples regarding enacting the strategy. Many comments fell under this category and will be taken into account for the models of engagement guide.

c) Editorial comments ranged from endorsements of an original definition or a particular alternative to comments regarding whether a strategy should always be used. The Delphi process is not designed to prioritize strategies, but we will take these comments into account for the engagement guide.

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Annex 4: Definitions and alternatives for the online voting

Adjust communication to target group

Original: Create separate communication plans if you want to engage different target audiences (e.g. formal or informal tone, how to approach target audience, generic or specific or individual approach, …).

ALT1: Create separate but coherent communication plans if you want to engage different target audiences (e.g. formal or informal tone, how to approach target audience, generic or specific or individual approach, …), incorporating both barriers and facilitators to communication encountered by different groups.

Alter patient/consumer fees

Original: Create fee structures where patients/consumers pay less for preferred treatments or products (the ones being researched) and more for less-preferred treatments or products.

ALT: Create fee structures where participants pay less for preferred interventions or products (the ones being researched) and more for less-preferred interventions or products.

Conduct ongoing training

Original: Plan for and conduct training in the citizen science project in an ongoing way.

ALT1: Plan for and conduct training and personal coaching in the citizen science project to ensure that participants and citizen scientist have the necessary knowledge, skills and methods to contribute effectively to the project in an ongoing way.

ALT2: Plan for and conduct training in the citizen science project to ensure that participants and citizen scientist have the necessary knowledge, skills and methods to contribute effectively to the project in an ongoing way.

Assess engagement barriers and facilitators

Original: Assess various factors that facilitate or hinder stakeholder and citizen engagement.

ALT: Assess internal (intrapersonal) and external (environmental) factors that facilitate or hinder stakeholder and citizen engagement.

Build a coalition

Original: Recruit and cultivate relationships with partners in the citizen science project.

ALT1: Develop a living network of contacts and collaborations among & around the project.

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ALT2: Recruit and cultivate an ecosystem of partners, participants and enablers in the citizen science project.

Provide supervision

Original: Provide stakeholders who will provide the innovation with ongoing supervision. Provide training for supervisors who will supervise stakeholders who provide the innovation.

ALT: Ongoingly facilitate stakeholders who will provide the innovation. Provide training for facilitators who will facilitate stakeholders who provide the innovation.

Recruit, designate, and train for leadership

Original: Recruit, designate, and train leaders for implementation of the citizen science project.

ALT: Recruit, designate, and train researchers and citizens for implementation of the citizen science project.

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