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COLLABORATIVE ENGAGEMENT ON SOCIETAL ISSUES

WP5 - Cooperation Quality Assessment

Cooperation analytics

Criteria grid and development plan

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Deliverable 5.1

WP5 - Cooperation Quality Assessment: Development and Implementation of the Cooperation Analytics

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Contents

I. Executive Summary

The Deliverable D5.1 WP5 - Cooperation Quality Assessment: Development and Implementation of the Cooperation Analytics is organized into five sections covering the conceptualisation and operationalisation of indicators to measure multiple cooperation practices.

After framing the scope and purpose of WP5 within COESO in section II, the deliverable presents first, in section III, a state of the art on the cooperation definition, the features that define more specifically cooperation, along with the methods of measurement in the literature resulting in a conceptual grid. The conceptual grid is relevant as it justifies the construction of indicators we define in the following sections.

Second, in section IV, the cooperation analytics' monitoring grid is developed in detail. It represents the main conceptualisation stage of cooperation analytics. In this section we create a correspondence table between every feature retained and its level of analysis from the bibliography. In this section, we define every feature as it will be adopted in VERA's cooperation analytics.

Third, section V represents the core of the cooperation analytics operationalisation. However, it is important to note that the operationalisation is still at a conceptual design phase, as the VERA platform is not developed yet. But this step constitutes an important translation of the concepts into criteria that can be quantified and presented visually to practitioners and social scientists. In this section, the monitoring grid includes an operationalisation of cooperation based on four levels of granular analysis:

- a typology of cooperation,
- the cooperation features that define four types of cooperation,
- the categorical values for each cooperation feature in link with every cooperation type,
- the indicator construction,
- the data and text corpora to be collected within VERA along with their analysis methods.

This section ends with the analysis of data visualization possibilities for the monitoring grid. Here we present the five main options retained. The indicators that will be presented to VERA users in the form of a monitoring grid are not a mere replication of the user activity tracked. Instead, the indicators will assess more broadly the cooperation practices in an aggregated way. The reason for this choice is that indicators, as a feedback, can directly affect the behavior of participants, to the point where they may try to conform to the scores and metrics, following what is called the "Goodheart effect" (a metrics that becomes the target of a behavior becomes a nasty metrics; i.e. used for autoreferential conformist purposes and not for reflexivity purposes anymore.)

Fourth, in section VI, the deliverable provides an overview of the five Pilots' state of progress based on interviews we conducted and additional ones conducted by Net7. Here we present five main observations we made on the Pilots' state of progress from an exploratory analysis. The section includes our main contribution and the challenges we are facing to develop cooperation analytics.

Finally, section VII concludes the document with the next steps for reviewing, implementing and testing the cooperation analytics here defined. The final section provides a view on where we are heading: to a close and experimental collaboration phase with Net7 and the Pilots that contributes to the development of cooperation analytics along with VERA's core functionalities.

II. Scope and Purpose: Cooperation Analytics Development

The SSH contribution to citizen science is often a blind spot in the field (Kieslinger et al., 2017). The COESO project sheds light on this blind spot through the development of a platform that will help cooperation between citizens and social scientists. This platform must support and amplify public engagement practices already established in several disciplines of the social sciences and the humanities (SSH) and allow the situated assessment of actors' societal issues. In particular, this will take place at the micro-level of citizen participation through a real-life test on 10 case studies. These case studies consist of five Pilots selected for a first testing-validation phase, and five other Pilots for a final-validation and improvement phase.

The micro-level assessment of citizen participation in scientific activities that COESO targets is based on two levels (levels three and four) defined by Muki Haklay (2012):

Participatory science (Level 3): "The problem definition is set by the participants, and in consultation with scientists and experts, a data collection method is devised. The participants are then engaged in data collection, but require the assistance of the experts in analysing and interpreting the results";

Extreme citizen science (Level 4): "Collaborative science is a completely integrated activity, as it is in parts of astronomy where professional and non-professional scientists are involved in deciding on which scientific problems to work on and the nature of the data collection so it is valid and answers the needs of scientific protocols while matching the motivations and interests of the participants. The participants can choose their level of engagement and can be potentially involved in the analysis and publication or utilisation of results. This form of citizen science can be termed 'extreme citizen science' and requires that scientists act as facilitators, in addition to their role as experts. This mode of science also opens the possibility of citizen science without professional scientists, in which the whole process is carried out by the participants to achieve a specific goal".

To a certain extent, COESO includes level 2 thanks to Pilot 5 that will integrate a "distributed intelligence" dimension engaging lay citizens in historical activities on the migration topic, thus increasing their awareness about historical science methods and knowledge about a central global issue. Distributed intelligence (Level 2) is "the cognitive ability of the participants is the resource that is being used. The participants are asked to take some basic training and then collect data or carry out a simple interpretation activity".

COESO Work Package 5 (WP5) is dedicated to the assessment of these levels of participation and will be integrated in the VERA platform as a continuous and direct feedback to Pilots stakeholders that contribute to the broader objectives of citizen science. More specifically, WP5 "Cooperation Analytics" provides the assessment and understanding of the cooperation conditions and the cooperation quality in the Pilots, based on a conceptual framework and quantifiable criteria made operational –later fully integrated into the VERA platform's functionalities-. Since COESO wants to advocate the importance of citizen science in the SSH, it must demonstrate the quality of these assemblages by assessing these results in a robust way.

However, this is not so much a question of conformity, or compliance with pre-established grids as it is often the case in the managers' style of regulation extended to scientific activity. The cooperation analytics that we define avoid being normative a priori. Instead, the analytics put forward the plurality of cooperation practices of social actors. The plurality of cooperation

practices must be accepted and valued since it does not make sense to experiment all the opportunities of a practice that is not so well developed and since it is a key element of motivation for citizens stakeholders, to be able to adapt their cooperation practice to their real life features. This has been shown in citizen science research: “a group of individuals [can] be deeply involved in the entire process of research while others participate in discrete activities such as data collection or analysis” (e.g., Farquhar and Wing 2008). Indeed, participative “initiatives arise in unique contexts, in response to different needs, meaning prescribed approaches are unreasonable” (Wiggins and Crowston 2010). A further approach presents ideal types of participation according to interests: “In general, typologies of participation and project design are best considered tools for understanding trends, as practice inevitably ‘blurs boundaries’” (Cornwall 2008).

If we put all these experiments in a more historical perspective as Sciences and Technology Studies (STS) often do, it is useful to understand where we come from in terms of the relationship between science and society. The first steps of scientific practice took place under the scrutiny of citizens, even though it was a limited number of “enlightened citizens” who participated. As Shapin and Schaffer [1986] (2017) show in their story of the air pump by Boyle, citizens and members of the Royal Society were invited to observe and to validate the experiment about the air in salons. It was not before the end of the 18th century that laboratories became the exclusive place where scientific hypotheses were tested as in the case of Lavoisier (on the same topic of air composition). The sophistication of devices and protocols increased a lot but it was more of a political choice to consider that labs should become separated areas from the public discussion. The scientific revolution evolved step by step towards a “confined version of science”, restricted to labs (Callon and Latour, [1991] 2017) and publications, where a specific style of debate can take place and be assessed as opposed to the open debate of politics and public opinion, where the media started to play a significant role in the more recent years.

The citizen science movement is a way to recover from this deep division of labor, of space, of knowledge between scientists, their journals and their labs, and the public sphere. However, one cannot consider this as a smooth move since the situation of both spheres have been crucially disrupted by the recent digital offers. The scientists are pressured for publications at a fast pace, in order to gain more reputation that will help them obtain more funding and consequently more projects to manage for more publications and fame, and so on. To trigger this virtual cycle, they are ready to blur the boundaries between the scientific publication system and the media sphere (they publish blogs, videos, articles and interviews in the media). At the same time, they are requested by elected representatives or by the civil society to become more accountable of their practices in terms of ethics, of anticipation of their research consequences and of connection to the real agenda of societies for a common good. There are no confined labs anymore and society is pressing for taking a more active part in the definition of the research strategies. This is true at a global level of governments, parliaments or NGO but also at a more local one for specific concerns by populations that are facing a high risk or a major crisis like it was the case for the AIDS crisis. Patients do not hesitate to become experts in the scientific domain that is addressing their very personal experience. It looks like these cooperation types rely only on the passion and investment of some citizens but not on a global and permanent strategy. We may say that conventions are not built yet to establish rules and principles for this cooperation and even less so for the social sciences.

The COESO project, by developing the infrastructure for these various forms of cooperation, is creating a technical platform, indeed, but this platform may become a very powerful resource for the design of conventions of cooperation. A convention (Eymard-Duvernay, 2006) requires an investment of form (Thévenot, 1986), a huge and long term activity to make stakeholders accept

a shared framework of principles, ontologies, decision-making processes, assessment practices, and so on that will become so comfortable for the new entrants at the moment the convention becomes widely shared. This is why a correct understanding and design of the features of cooperation for social scientists and citizens is very relevant at this historical moment and must be carefully processed. Cooperation analytics is only one of the components that will help to make explicit exactly what stakeholders do and how they can think of it.

Operationalised and implemented from a conceptual grid into a monitoring grid, the cooperation analytics serve Pilots' teams to receive permanent feedback on the quality of their cooperation so that they can adjust in real-time their practices, if necessary. As Bradbury and Reason (2008) suggest, project interests and outsets evolve throughout time, actors are often confronted with changes and "the quality of participation must be evaluated on an ongoing basis."

Three broad and initial types of criteria are established to assess the conditions and the quality of cooperation in citizen science within the COESO project:

1. **Internal quality criteria**: they are based on the operational work's content (scope, objectives, the product, the outputs), and the quality standards that are established within the team.

2. **External quality criteria:** they refer to the compliance of the project with external quality and ethical standards within the project networks.

3. **Process criteria**: they focus on the cooperation practices themselves, in particular to the learning process between research stakeholders (what the Horizon2020 Swafs-27-2020 call names "knowledge exchange"). This learning process concerns the framing of the project, its conceptual background, the level of shared vocabulary and its progressive evolution.

These types are further detailed and completed in Section IV, Cooperation Analytics Monitoring Grid, (see Table 1) based on the state of the art presented in the next section.

III. State of the Art: Conceptual Grid

Our state of the art is guided by three selection criteria:

- (i) the terms “participation”, “collaboration” or “cooperation” appear in the literature,
- (ii) indicators for those terms are established with or without concrete operationalisation,
- (iii) the use of technology is evoked.

In the following, the main cooperation criteria defined by authors in the SSH and the Computer-Supported Cooperative Work (CSCW) community are presented first, including the specification of qualitative and quantitative methods that serve for establishing our own methods of data collection.

Secondly, selected works are presented as they consider a plurality of cooperation forms and the few references that operationalise cooperation. In particular, Liu et al. (2008) contributed to the operationalisation of cooperation from a conceptual framework that is implemented into digital platform functionalities. We extend this literature by bringing together theoretical and empirical criteria to measure cooperation practices within online platforms based on practical citizen science case studies. We conclude with a demonstration of how we intend to establish the operationalisation from the literature. We put in place a demonstration that is drawn from the analysis of the French project *Platform for Collaborative Engagement on Societal issues* (PLACES). PLACES has been a two-year project (2018-2020) coordinated by the École des hautes études en sciences sociales (EHESS) and OpenEdition Center, funded by the French Ministry of Culture. Conceived as a COESO proof of concept, providing functional specification for prototyping the service, PLACES project embarked three Pilots focused on collaborations between SSH researchers and journalists with an observation protocol providing the first recommendation for the design of VERA (see https://places.hypotheses.org/).

The state of the art supports the concepts retained in the next section (Section IV: Cooperation Analytics Monitoring Grid) to build the cooperation analytics. The concepts are summarized in a conceptual grid that is confronted to an operational monitoring grid in the fifth section where indicators are operationalised as they will be actually implemented in the VERA platform. Section V also presents a review of data visualization options for providing practitioners the monitoring grid as a graphic and learning tool. The last section covers our next operational steps.

Bridging Cooperation and Citizen Science

Cooperation is used “because of its potential to encourage information sharing, negotiation of meanings, and building common understandings” (Liu, 2008). These elements are key to citizen science. Digital platforms are often seen as a key tool in citizen science and in supporting cooperative work. But these two fields, citizen science and cooperation, are insofar distinguished. To this day, cooperation has gained little attention in citizen science literature across disciplines. The term is evoked without a formalised conceptualisation and often interchanged with collaboration, coordination and participation. The term cooperation is neither defined with a systematic operationalisation through quantifiable criteria and indicators. One can make the same observation for the term participatory and its quantification in participatory evaluation studies. A group of authors have paid particular attention to this gap (Kieslinger et al., 2018).

To define cooperation, there is a broad distinction that has been set from other concepts that serves as a starting point for integrating cooperation in citizen science. To some authors, coordination requires individuals to coordinate the processes of work, collaboration involves individuals working toward a common goal but doing so by completing separate tasks and cooperation demands a great amount of personal contact and quality of communication because many of the tasks are carried out concurrently as shared activities, see Borghoff and Schlichter (2000); Neale et al. (2004) in Liu (2008).

One plausible reason why broad terms are used interchangeably is that the field of citizen science gathers a wide array of different practices known under different names: peer-to-peer science, participatory science, community science, community-based research, public participation in research, crowdsourced science, research-action on one side, and public engagement on the other, see an exhaustive list of terminologies in Haklay et al. (2021). In this plurality of practices, a core element holding together citizen science is the development of platforms for supporting practitioners, mainly coming from life sciences. These platforms are often designed for helping to achieve "citizen science outcomes" (Haklay et al., 2021). For instance, crowdsourcing platforms request citizens to collect and label data. Data are then shared with researchers, and in education, for knowledge production[1]. In general, "citizen science outcomes can range from knowledge outcomes, such as journal articles, or information used by participants to address issues of local concern, to practical policy outcomes and tangible outputs can range from an open data repository to a personal checklist of nature observations." (Haklay et al., 2021). Another recurrent participatory evaluation criterion is to know if citizen science projects include citizens throughout the whole process of knowledge production and cover citizens' societal issues as formulated by the social actors. In citizen science projects, outcomes are often considered to evaluate participation. One study that pays particular attention to the processes in addition to the outcomes is Kieslinger et al. (2018).

Alan Irwin (1995) focuses on two convictions intersecting for establishing a relationship between citizens and research: the conviction that research should respond to citizens' concerns and needs; and the conviction that citizens themselves are able to produce reliable scientific knowledge. We seek to approach these convictions differently, in a reciprocated way (i.e., what practitioners do to each other) and not in an unidirectional way (i.e., what researchers do with citizens) by focusing on the concept of cooperation. Cooperation and its measurement provide a reciprocated dialogic perspective on social actors (despite their role) (Sennett, 2013) within a process, which ultimately contributes to sense making (Garfinkel, 1984).

The literature on cooperation -or related concepts- is extensive and multidisciplinary. However, the majority of research is based on qualitative methods. Less is explored the definition of quantifiable criteria of cooperation which is our main interest. In addition to the fields we cover in our state of the art, we list below the main fields where cooperation studies can be found as a guide for future work.

- Sociology of work
- Sociology of organizations
- Design studies in Human-Computer Interaction or "CHI"
- Socio-psychology
- Cognitive sciences: distributed cognition, collective circulation
- Ethnomethodology: common sense
- Behavioral ecology

[1] See citizen science NASA projects https://science.nasa.gov/citizenscience

- Social network analysis: see in particular Pentland (2015)
- Game theory
- Intercultural management
- Sociolinguistics
- Creolization knowledge
- Translation studies
- Science and Technology Studies (and scientometrics)

In the human and social sciences literature, when looking for more formalised and computable approaches, we can find the concept of cooperation in management, in particular in the organizational learning field, in economy, in particular in Game Theory, and more broadly in communication science, education and sociology. In addition, in the Computer-Supported Cooperative Work (CSCW) community where we can find an interdisciplinary literature mixing SSH and computer science, cooperation criteria are quantified and measured for the design of digital platforms that mediate social actors' practices. In CSCW, as in the citizen science literature, when studies are focused on the implementation of indicators within digital platforms, the indicators are defined so that actors are able to analyse the goals and tasks they have defined. These indicators do not measure the cooperation itself. One rare project fully focused on cooperation is the Google Wave project[2] that did not become truly operational (Sennett, 2013).

In 1998-2000, Bernsen et al. (1998) was part of a European project that was supposed to deliver a platform that would create a virtual environment for supporting cooperation activities in work settings or everyday life situations (e.g. planning a family trip). This project, Magic Lounge, was led by LIMSI at CNRS in France and Bernsen et al. (1998) contributed to the fieldwork and usability testing phases. The project clearly demonstrated the irrelevance of the Communicator model (Winograd and Flores, [1987] 2008) that was the framework for the Magic Lounge project (Bernsen et al., 1998). The participants were required to elicit the meaning of their speech acts so that the system can classify, track and make suggestions for the next steps of interaction starting from these acts. The only fact of being obliged to be explicit while engaged in an action, created a well-known "cognitive overload" due to "double tasking" constraints. This lesson will be used in the design of our cooperation analytics where the users will not have anything to declare except at the start of the project. The system must be able to extract what is significant for the cooperation from the traces of behaviour.

On the one hand, the SSH literature contributes to the conceptualisation of cooperation criteria but the criteria are often analysed in situ through observations, before the project starts or a posteriori by means of interviews and surveys. citizen science projects are also evaluated in the same way according to a literature review: "There are currently no commonly established indicators to evaluate citizen science, and individual projects are challenged to define the most appropriate road towards collecting evidence of their impact." (Kieslinger et al., 2017). When participatory criteria are defined, they lack a computable translation in order to be actually quantified, implemented in platforms and compared across case studies but these criteria serve as a starting point for conceptualizing cooperation. On the other hand, the CSCW literature focuses on the design of platforms and the methods to quantify and measure cooperation outputs within the platform. The CSCW literature lacks in this way a conceptualisation step issued from situated societal issues based on empirical case studies that bring into the platform the real practices of actors. In this way, the platform design will adapt to the actors' realities and not inversely. One main challenge in developing cooperative platforms is that designers tend to make actors adapt to the platform once its development is finished (Sennett, 2013).

[2] https://en.wikipedia.org/w/index.php?title=Google_Wave&oldid=1028726431

Criteria Defining Cooperation

In management literature, Koster et al. (2007) suggest to qualify cooperation through *task interdependence* and the *informal network content*. The former refers to the "job descriptions of employees, that is dependent upon the person's formal position and the technology used". The latter refers to "personal relationships between members, independent from the position they have and from the tasks to accomplish, and activities to attain social resources: emotional and social support, person-to-person contact".

To Sanders and Schyns (2006), social exchange and reciprocity define cooperative behavior according to their theoretical contribution. The reciprocity is based on three factors: "equivalence, immediacy and interest". *Equivalence* is when "both parties attach the same value to what they get as to what they receive", *immediacy* is "time passed between a shown behaviour and the return may be of importance at least in the beginning of the exchange process". Finally, *interest* is relevant as "In the highest quality relationships, the interest focus is on the other member of the relationship, reflected by an unselfish devotion and deep concern for the other."

Josserand (2004) puts forward the concept of "communities of practice" to approach cooperation. *Communities of practices* are "groups of people who share a concern, a set of problems, or a passion about a topic, and who deepen their knowledge and expertise in this area by interacting on an ongoing basis" (Wenger et al., 2002: 4). To analyse cooperation within communities of practices, there are three "modes of control" presented by the author (Josserand, 2004) which are defined according to Ouchi (1979; 1980): "clan, bureaucracy and market."

Following Jamali et al. (2006), "effective communication" is key as it has direct implications for the dynamics of teamwork and collaboration (Holton, 2001). *Effective communication* is here framed as "the ability to organize, create and disseminate information".

More specifically, communication can be framed as an *exchange of knowledge* to produce science (Boullier, 1984). The tension between divergence and convergence is considered as a structural feature of social life or reason (Gagnepain, 1994). Even though people pretend to aim at cooperation they will face conflicting situations where some participants will look for distinction, personal recognition or control or benefits to the detriment of the collective orientation. And this behaviour should not be disqualified but rather described and accepted as a real life environment and dynamics of social life. More interestingly, this tension can be observed on the 3 other cognitive capacities of human beings. Their linguistic capacities will be affected by this social tension at the levels of the *language* and at the level of the distribution of roles for the production of *knowledge*. The tension can be found between more idiomatic expressions to the point of using a quasi *jargon* versus the search for a common language, a *koinè*. The same tension will apply to the way human beings use their *technical capacities*, where one can look for a specific fabrication differentiation while others will look for standardized tools. The division of labor itself is organized with more or less specialization. All these will be labelled *"style"*, a social way of designing technologies. And finally the third capacity of human beings is also affected by this social tension, the capacity of *norm*, the normative regulation of our behaviours based on our will and desire and the ability to autoregulate our impulses. Some will try to let their drives speak and pretend to be free from all regulations and others will require compliance with collective norms. Who is in charge of these decisions and norms design is also a social challenge that lets the social tension between divergence and convergence take place. No one can escape from this social dynamic, permanent and contradictory, and this is why a cooperation comprehensive model should not be normative but open to the various ways of making a livable

space for these tensions.

Broad and abstract motives of cooperation are defined by Lopes et al. (2009). Despite their relevance, they are hardly quantifiable in real-time cooperation practices. For instance, the motives are *relational satisfaction, commitment to social, moral norms and values.*

Other criteria are defined in respect to the "process and feasibility" like *evaluation and adaptation, cooperation and synergies, target group alignment, facilitation and communication, collaboration* (Lopes et al., 2009) which are not operationalised in order to be measurable within a platform, since the criteria are used for questionnaire items.

In sociology of communication, a method that has the potential to be quantifiable is the identification of common references of social actors in citizen science. Morillon (2021) suggests an epistemological analysis of participation based on documents and communication exchanges (reports, minutes, emails) between researchers and citizens. The analysis remains qualitative and based on surveys where participants are requested to define a posteriori, the common references that were identified by the researcher. This author highlights the relevance of communication processes analysed via written traces and their formats for cooperation that can be reused in VERA with automatised quantifiable methods like text mining.

Morillon (2021) identified four epistemological families. Interestingly, the author draws these epistemologies from interactional practices between actors. The epistemologies with their respective common references in French are:

- positivism: « impact », « efficacité », « émetteur », « récepteur », « transmission »
- interpretativism: « interprétation », « représentation », « sens », « contextualisation », «subjectivité »
- interactionism: « relation », « interaction », « transaction », « sens partagé/négocié »
- constructivism: « processus », « co-construction / co-création de sens », « action collective », «coopération »

In this study is not presented the method for identifying and selecting such terms. However, the communication analysis of Morillon (2021) contributes to highlighting the relevance of analysing references produced by actors within continuous textual practices. Hence, communication analysis can be approached as a learning process, in contrast to the classical model of communication (information transmission/reception), where *collective intelligence* takes place according to the common sense knowledge built in situ by actors (Morillon, 2021).

In the state of the art, we can find a variety of definitions of cooperation along with multiple criteria for its measurement. We define cooperation as a set of multiple interdependent and communicative actions that can be supported by online platforms in order to establish a dialogic process, as well as its reviewing process for sense-making towards a common goal. The definition of cooperation settles a common ground for analysing citizen science projects. However, to operationally measure cooperation, specific features are identified in the literature for covering the scope of our definition that ultimately define a plurality of cooperation practices.

Towards a Cooperation Typology

Multiple types of participation have been defined in the literature but methods for measuring them are not identified. One author that accounts for "reciprocal forms of engagement" in citizen

science based on observations is Millerand (2021). Engagement is relevant for cooperation within citizen science projects as "a process made up of actions and experiences that contribute to giving meaning and building an identity of an "engaged" or "committed" person over time (Ibid.). Three types are defined but they do not present any features that enable researchers to identify and assess them in other projects. The types defined are:

- first, the scientific citizen: "a citizen in capacity, involved, able to contribute",
- second, the volunteer citizen: "the one who gives, executes following the rules that the researcher will have validated",
- third, the militant citizen: "who is committed to the service of a cause".

To analyse these ideal types, the author (Millerand, 2021) opposes engagement to expertise and sets three types of participation between researchers and citizens:

- the classical model where responsibility is assumed by a certified scientist,
- the Wikipedia model based on the volume of contributions coupled with compliance with contribution rules,
- and the hybrid model involving delegations of responsibility in certain fields of expertise deemed to be better among citizens.

In ecology, Shirk et al., 2012 analyse multiple platforms and participatory practices where data collection and measurement choices, as well as feedback provided, are elements of high relevance to define a balanced structure of participation. Authors put forward that these choices must be negotiated between actors but they do not specify the criteria and measures. From a qualitative-comparative case study analysis, authors define five models of public participation in scientific research based on the degree of participation. While the degree is not of interest for us, the plurality of projects defined as models are relevant to map cooperation.

The participatory models (Shirk et al., 2012) are the following:

- *Contractual projects*, where communities ask professional researchers to conduct a specific scientific investigation and report on the results;
- *Contributory projects*, which are generally designed by scientists and for which members of the public primarily contribute data;
- *Collaborative projects*, which are generally designed by scientists and for which members of the public contribute data but also help to refine project design, analyse data, and/or disseminate findings;
- *Co-Created projects*, which are designed by scientists and members of the public working together and for which at least some of the public participants are actively involved in most or all aspects of the research process;
- and *Collegial contributions*, where non-credentialed individuals conduct research independently with varying degrees of expected recognition by institutionalized science and/or professionals.

The authors' (Shirk et al., 2012) analysis is of particular interest as they develop a design framework for platforms according to the quality of participation of these models. The quality is limited in the study to the comparison between a plurality of inputs provided and the outputs achieved by each actor in addition to the impact that they have in public engagement, e.g. socio ecological systems. In other words, who does what, for what purposes, in the participatory platform: "At the heart of the design process is the quality of participation. The design and implementation of every project requires decisions to be made about whose interests can and should be addressed, and how the end goals, or desired outcomes, are defined. Resulting choices

in project design reflect how those interests are considered and negotiated [between co-researchers (community members and scholars) and developers]." (Shirk et al., 2012)

More concretely, to evaluate and typify citizen science projects, Haklay et al. (2021) propose 10 factors of classification: "activeness, compensation, purpose of the activity, purpose of knowledge production, professionalism, training level expected, data sharing, leadership, scientific field and involvement of the participants". The 10 factors are decomposed in total in 61 sub-factors. The ten factors will be useful to develop a profile page in VERA platform as a starting point of the cooperation practices online.

Outside citizen science literature but still related, Sarah Stonbely (2017) describes six types of collaborative journalism. The types are:

- "Temporary and Separate",
- "Temporary and Co-creating",
- "Temporary and Integrated",
- "Ongoing and Separate",
- "Ongoing and Co-creating",
- "Ongoing and Integrated".

These types provide two relevant general criteria to retain: the *temporal dimension of collaboration* and the *type of interaction*.

Broadly speaking, there is a consensus in research about the relevance of having shared goals in cooperation. However, according to Tuomela (2000) there are different kinds of cooperation that are possible to achieve and they do not depend on shared goals. In some situations, actions target private goals but the actions might lead anyway to a cooperation shared goal because the situation is already cooperative. Indeed, the author distinguishes the individual and social actions from the individual and social situations. Importantly, cooperation practices rely on conventions. Tuomela (2000) does not refer to Livet (1994) but both authors agree on the relevance of *conventions* for achieving collective actions, in Livet's (1994) words: a mutual tolerance. Tuomela (2000) contributes to integrating to game theory a social approach that is based on supposed conventions that drive actors. This contribution pushes forward the game theory that is mainly based in opposing cooperation to competition according to a number of contributions. To illustrate the relevance of conventions, Tuomela provides the following examples: a person lights a candle on Independence Day based on supposed common conventions that everybody else will also light a candle. On the contrary, two persons will play a tennis game for competition where conventions are made explicit. Another example of the relevance of conventions, in this case implicitly, is two persons carrying a table jointly where every person knows that it is necessary to lift the table on one side to achieve a cooperative goal. Within this socioeconomic approach, Tuomela (2000) suggests two main types of cooperation: "cooperative acting together" is a strong kind of cooperation with collective shared goals (in terms of end goals, process, and means to achieve the goals), "cooperative in collective actions" defined as compatible co-actions, as in the Prisoners' dilemma situations.

Finally, Le Cardinal et al. (1997) conceptualize cooperative types as a communication process that can be based on trust and a contract. When social actors find themselves in a project, some might cooperate either on trust or in a contract. The former implies mainly tacit practices and relationships; the latter implies an explicit engagement and rules. However, they do not have to be necessarily distinguished. Trust and contract are complementary. This complementarity is explained by authors according to six key concepts:

- control,
- clarity,
- constancy,
- connivance,
- complexity,
- change.

The first three concepts define a contract and the last three trust.

The *contract definition* is based on a rational explicitness and a static knowledge that is registered on paper: tasks, contributions of every party, evaluation, deadlines, remuneration. First, the control of objectives serves the system evaluation overall and more particularly, the rights and duties of actors, the results and qualities expected in the project, as well as the penalties. Second, the clarity of the prescribed work enables actors to break down a project into sub projects and tasks. It is based on a problem-solving modality, a focus is given to the analysis of objectives, motives, roles and status. The clarity provides an exhaustive list of actors and skills, as well as the actors' obligations in respect to the resources available and the objectives expected. Third, a contractual cooperation requires constancy in the organization forecast until the end of contract (Le Cardinal et al., 1997, p. 79).

The *trust definition* is based on a systemic and implicit rationality. It relies mainly on a living knowledge that aggregates actors and problems to solve, composes tasks for the success of the project with driving dynamics of interaction, and manages complexity, undesired effects and the cooperation safety. First, the connivance aspect provides common references of evidence, a coherence and shared growth in 'thinking', 'saying', 'doing' for taking initiatives. Second, the complexity of real work puts forward the unique meaning of actors, mutual ignorance, information transfer, the role of cooperation, personal authority for driving actions, the relevance of mutual trust and relationship building, the incidence of representations made between actors in the building of their identities. Finally, the trust in cooperation highlights the change. Changes happen in the group relationships, cooperation level, mutual trust without time limit and changes in the sociotechnical context (Le Cardinal et al., 1997, p. 79).

Le Cardinal et al. (1997, p. 54) define *four types of cooperation* according to their *benefit*: by necessity, security, facilitation, pleasure. The authors put forward that by making explicit the benefit of cooperating with others, actors can evaluate the advantages and disadvantages of it.

First, *cooperation by "necessity"* requires the skills and availability of another person to accomplish a project. Although some actors try to do the tasks on their own, the project may perish if the necessary skills of someone else are not requested. For instance, when the actor has administrative skills but requires some additional skills in the legal domain.

Second, *cooperation by "security"* is a type of cooperation where actors work together in specific tasks to attain a security level that mitigates the risks foreseen although the tasks can be accomplished on their own. The security can be provided by an operational action, advice or simply a joint presence that provides confidence.

The third type of *cooperation by "facilitation"* is when actors decide to work together to improve the quality and reliability of the results that can be obtained. The efforts and time to dedicate to the project can be facilitated by cooperating with others.

Finally, *cooperation by "pleasure"* is the action of cooperating with somebody because it is pleasant to work with that person. It provides company, and potentially, a friendship beyond the

project. While this type of cooperation can accelerate and improve the work to be done, it can also slow it down. It makes the encounter the first priority before the cooperative work (Le Cardinal, et al., 1997, p. 55).

These types of cooperation enable us to understand the driving actions for cooperating in citizen science according to the advantages, or not, that actors perceive in the action. The main limitation of the approach proposed by Le Cardinal et al. (1997) is that it relies more on the expression of fears, incentives and tentations, which is, from our own experience when using their method, an overwhelming requirement for the members of the project. And the attention to the on-going process of cooperative work is underestimated. Moreover, the conditions that define cooperation through trust and contract provide a more holistic perspective on the way practices are established beforehand and the practices that actually operate in the cooperation process. This distinction between trust and contract can be more generally translated into explicit and implicit forms of cooperating, which can be complementary and tracked in citizen science online platform-based projects.

While the literature in cooperation presents a rich plurality of cooperation types to avoid positioning actors in an absolute statut, it is missing the development of the on-going process that ultimately leads to those types of cooperation. The pragmatic sociology offers a theory about collective action according to conventions that serves us as a conceptual framework for assessing cooperation practices throughout time. Moreover, this theory presents an additional typology of collective actions that feeds our construction of cooperation typology.

Building Collective Actions Through a Revision Process

According to Livet (1994), *conventions* -whether they are made explicit or not- act as a supposed common framework to pursue a collective action. As a supposed framework, conventions remain a belief. Each actor produces different representations about the conventions' collective meanings, which are inaccessible to another actor for verifying them. Because conventions are human interpretations (in the mind), what one actor supposes as collective conventions do not provide any guarantee to pursue an action. The condition of felicity to pursue a collective action is to achieve a mutual tolerance in the course of the action. *Mutual tolerance* means that actors need to tolerate a certain level of uncertainty because the communication process always implies misunderstandings that cannot be verified by its reliance on conventions. Consequently, actors cannot obtain guarantees about the intentional actions of others but this state does not prevent them from pursuing an action, provided that some signals can trigger a phase of revision in their perception, anticipation and expectations. Moreover, mutual tolerance can be achieved throughout an iterative *revision process* in the course of action and it is considered as the only way to avoid the "common sense knowledge" aporia: people are supposed to cooperate by sharing a common sense knowledge but no one can account of how this common knowledge is built and becomes considered as reliable to direct the course of action. In fact, it is just a "supposedly shared knowledge" that is used as a proxy until it might get contested by the observations or contradictory signals that will trigger a revision process. Stating that knowledge is situated, the author shows that actors can revise collective actions by their repetitiveness, which is expressed along with body movements or any other signal in the environment. The latter are to the author, "decidable features" that enable collective actions because they come along with collective beliefs, the conventions. Otherwise, a person cannot answer in a way that is known by the other, for instance shaking hands in one culture when two persons first meet face-to-face. In online situations, when a user sends a like to another user who created a post,

the latter supposes that the former agrees on the content of a post that she just published. These "embodied repetitive traces" as we suggest to call them, can be easily accounted for in platforms to understand how actors follow a collective action.

Livet's (1994) develops furthermore three types of collective actions according to the conventions' modes of explicitness, degrees of accessibility and modalities of feedback obtained collectively to individual actions.

- The first type of collective action is the "joint action". This is the highest level of cooperation recognized as it is based on a reviewing process of mutual adjustment and correction of actions in situ.
- The second type of collective action is the "action à plusieurs" (in English we suggest the term "multi-part action" as a translation). In this type, individual actions follow their course of action alone but the interaction with others is mandatory for accomplishing a collective action.
- Finally, the "action together" is based on predefined explicit conventions that enable actors to coordinate themselves at a distance.

As it is shown, cooperation definitions in the literature include a plurality of criteria, including a plurality of resulting cooperation types. Research has mainly assessed those criteria by means of qualitative methods and, to a certain extent, with quantitative methods that are conducted at small scale (i.e., sample, data granularity). Some contributions, like Holton's (2001) in Jamali et al. (2006), are only theoretical. Another important factor to highlight is that cooperation is often measured upstream or downstream. Cooperation is not assessed as an on-going process. Instead, cooperation practices are evaluated before or after they take place. For instance, cooperation criteria are assessed by Koster et al. (2007) by means of survey techniques, where questions or declarative statements are formulated in order for participants to assess them with an x-point scale. Other studies (Josserand, 2004) present interesting comparative analysis but these are based on a multiple case study design and researchers conduct interviews without specifying the criteria to assess. In the following, we focus on references that present a clear quantification of cooperation.

The Quantification of Cooperation

Following Liu (2008), "it can be argued that all work is cooperative, but this depends heavily, according to the literature, in interdependence with others to achieve success." While coordination includes plans, procedures, and processes for managing tasks, activities, and resources, cooperation usually requires individuals to adjust their actions for the sake of the collective goal. This adjustment of actions coincides with Livet's (1994) revision process. Finally, according to Liu's literature review (2008), co-construction is the highest level of interdependence, involving the negotiation and construction of meaning. Co-construction includes accepting divergent insights, reconstructing meanings and re-organizing new ways of working to achieve shared goals according to Bardram (1998).

In Liu's (2008) literature review about the operationalisation of cooperation, we can see previous studies are mainly using survey methods. Cooperation is measured by asking participants to rate numerically cooperation criteria. For instance, how actors evaluate compatible and mutual goals in their work, how they perceive the cooperation and supervision of their peers, as well as conflicts and suggestions discussed within teams, see Tjosvold and Tsao (1989), Tjosvold et al.

(2004), Bacon and Blyton (2006), Sinclair (2003) in Liu (2008). On the contrary, Liu (2008) combines qualitative and quantitative methods to collect data and analyse them within a platform in the health sector. Although the study contributes mainly to problem-solving and reporting events within the platform, she provides specific indicators that can be applied in other types of cooperation dynamics. The author (Liu, 2008) defines cooperative work based on five elements of interdependence and interaction according to Johnson and Johnson (1996, 2005). The five elements are "positive interdependence, individual accountability, promotive interaction, social skills and group processing":

- *Positive interdependence* refers to individuals linked with others so that one cannot succeed unless they all succeed.
- *Accountability* is the sense of responsibility to contribute efforts to accomplish the common goals.
- *Promotive interaction* is the effort to encourage each other to complete tasks and reach the common goal through providing help, exchanging information or resources, using other's opinions for decision making and achieving mutual benefits."

To measure these elements, authors (Liu et al., 2008) principally account for action logs obtained from the platform already operational: mainly reporting and resolution activity, and content analysis through a Principal Component Analysis where data were categorized by coders. Among the elements we retain are:

- time spent on different actions in the platform,
- number of total actions taken for an event,
- total characters in event details
- and suggestions given to others.

Khawaji et al. (2013) analyse trust and cooperation using natural language processing (NLP) techniques in addition to individual actions. To analyse whether the establishment of trust is associated with linguistic cues, [the authors] used the Linguistic Inquiry and Word Count (LIWC) tool to investigate several linguistic categories. Four linguistic categories: positive emotion, negative emotion, assent and dissent (negations) are analysed with LIWC following Pennebaker et al. (2007). The hypothesis is that text can enable researchers to identify the friendly, respectful and in contrast competitive attitudes of actors towards others while operating tasks together. Here trust is defined in terms of positive attitudes that enable cooperation. One limitation of this study is that cooperation is defined according to the Prisoners' dilemma, which mainly focuses on complementary individual contributions and rejects social actions that take place by the definition of supposed collective conventions. However, we retain the use of NLP techniques for analysing communicative interactions between social actors.

Moreover, the tradition of the *prisoner's dilemma* (and the game theory that it is part of) inspires many cooperation research such as a very famous book by Axelrod ([1984] 2006), "The Evolution of Cooperation". The evolutionist discussion of cooperation is not so relevant for our concerns but the extensive use and documentation of the prisoner's dilemma might be useful in citizen science cooperative activities. Two features can be mentioned in the final outcomes of the book.

First, *the time and the repetition of turns* in the prisoner's dilemma game is a very significant feature of the experiment. Because when participants have just one bet to make on *cooperation* or defection, they will usually choose a *defection* that looks more rewarding at first, just because they will have no opportunity to learn from each other's behaviour. But at the moment many turns are announced and their number is not determined, the learning process can take place and participants get involved in a strategy of anticipation where cooperation may become

valuable. For cooperation analytics in citizen science, it means that the status of a *one-shot project*, with no chance of being extended or reproduced, creates more incentives for defection and less for cooperation.

Second, the best strategy in the long term is always the *TIT for TAT strategy* which means reproducing the behaviour of the partner at each turn. When one of them starts adopting a cooperative attitude, it is much more beneficial to adopt this attitude in order to share the rewards and this attitude can be reproduced in the long term until there is some defection that should also be reproduced by the other partner. By doing so, there is a common learning process about the consequences of defection and its cost. But the best advice is not to defect first and wait for some denial from other's behaviour to change strategy. This can become meaningful for cooperative projects in citizen science where participants do not know each other and have a lot of different expectations. The choice to anticipate cooperation seems to be the best chance to obtain cooperation of all parts.

Another study (Soulier and Tamine, 2015) in documentation studies and engineering suggests that the predefined roles of actors are not as relevant as the meta-roles that are spontaneously defined when collaborating with others. Using an online platform of research and catalog of documents, researchers designed a non-supervised algorithm of classification and an algorithm of optimization (called Coll Clique) to contribute with complementary skills online. Authors consider collaboration by means of research requests in chronological order, clicks given on research results, associated results irrelevant for actors (the searching behavior in the platform), the similarities and differences of these elements in respect to other users. In this way, the quality indicator of the platform for indexing collaborative documents is the relevance of the *users' complementary behavior*. These algorithms allow the system to identify the skills and strategies of documents' research, which are complementary to suggest results. This algorithmic approach and the definition of meta-roles based on collaborative contributions is appropriate for citizen science projects that depend highly on the quantity, quality and share of documents in cooperation practices. For instance, in investigative journalism projects.

Based on agent-model simulations, collective actions are accounted for by Gongora Y Moreno and Gutierrez-Garcia (2018) to distinguish cooperation from competition. A main indicator is the "cumulative modification of agents' profiles" throughout time based on the following criteria:

- "(i) profile (rational egoist, conditional cooperator and willing punisher);
- (ii) attitude towards group pressure (either flexible or independent),
- (iii) structural position within an organization (Hierarchical level and organizational unit),
- (iv) amount of endowments (dons), and
- (v) perception about the cooperation of others".

Here the notion of modification throughout time is relevant for citizen science so cooperation is not considered in a static manner or as practices to evaluate only a posteriori. This modification notion is related to the length of projects: "citizen science activities and projects can range from an activity that happens only once (one-off), over a short-term (a few days or weeks), infrequently (once a month or less) and/or long-term (every day and/or over a long period of time) (cf. Ballard et al. [26])." (Haklay et al., 2021).

A study that evaluates scientific outcomes in citizen science defines the following measures: Numbers of papers published, Numbers of citations, Numbers of grants received, Size and quality of citizen science databases, Numbers of theses, Frequency of media exposure (Bonney et al. 2009 in Kieslinger et al., (2017).

Finally, we retain the scientific tasks that can be tracked on a platform for defining the participation of actors in the project according to Shirk et al. (2012). These are:

- “Choose or define questions for the study,
- gather information and resources,
- develop explanations (hypothesis),
- design data collection methodologies,
- collect samples and/or record data,
- analyse samples,
- analyse data,
- interpret data and draw conclusions,
- disseminate conclusions/ translate results into action,
- discuss results and ask new questions”.

Conclusion:
A Demonstration of Conceptual Operationalisation from PLACES

The experimental citizen science project PLACES « PLAteforme Collaborative pour les Enjeux Sociétaux » offers a renewed perspective on collaboration between researchers and journalists. It was conceived as an “integrated and participatory process for the production of knowledge in which journalists and researchers would be equally involved” in the [whole research pipeline:] choice of topics, choice of the subjects of society on which they were going to work and in the definition of the methods and means of data collection implemented."

In doing so, PLACES provides a fertile qualitative analysis for defining cooperation analytics in citizen science. Indeed, PLACES conducted a systematic comparison of collaborative practices between researchers and journalists that enables us to extract multiple features that can be collected and calculated within a platform for assessing cooperation. To conclude the state of the art, we use PLACES as a reference to make a demonstration on the way concepts and qualitative criteria can be operationalised into cooperation analytics.

In their research project, Chibois and Caria (2020) offer qualities of evaluation and comparison between three citizen science projects between journalists and researchers. The report offers the necessary conditions of collaboration between actors. One important dimension analysed in their report is the temporal dimension according to every project’s practices in five distinctive phases. The phases are writing the project, problematizing, data collection, data processing, final production. From this report on the temporal dimension, we extract and reformulate the criteria that are useful for measuring cooperation. We separate them into three classes of criteria:

- profile and project,
- operational activities
- final production activities.

From this extraction we create categorical values (separated with commas) and combinations (designed by the attribute AND) that can be identified across citizen science projects. For each item, or multiple items when they are related, we provide their relevance for cooperation after presenting their respective values.

Profile and Project

- *Contract:* Full-time, Part-time, AND Long-term Duration, Short-term Duration

The contract type and duration set for each actor establishes the availability for collaborating together.

- *Establishment of common agenda:* before work starts, during working time, after the project ends

When actors define an agenda and the modality how it happens influences the availability agreement that is established.

- *Team integration:* before the project starts, during the project development phase

When a team member integrates the project later than others or when the project already started, there might be differences in apprehending the project that was, or not, conceived together.

- *Parallel constraint*: multiple professional projects developed, family responsibilities

In certain projects, some actors had parallel constraints that influence the availability for working and progress of task development. The constraints on one side lead to the other actor to progress tasks alone or without consulting the other person.

- *Objectives:* Individual, Common AND from the same occupation, different occupation

Actors that had clear distinctive objectives according to their respective occupation lead to tasks in parallel that influence the common objectives to be developed together.

- *Target public:* same network, different network

The origin of the public that every actor targets influences how actors coordinate themselves to interview participants for data collection or produce some material.

- *Institutional formalities*: are the same, are different for each actor

Every institution where the actor is attached has different codes and formalities to follow, for instance the validation step of the material produced.

- *Career status:* starting, in transition, ending

The career status of actors determined how engaged and available they were for working together. Part-time working members were more busy and overworking hours to achieve the projects' goals. In addition, researchers culminating in their PhD were busy looking for new job opportunities and other tasks that help them develop their career. This was the same situation for journalists looking for stable jobs.

Operational activities

Problematizing time: once and for all before the project starts, updated during the project development phase AND alone, collectively

After the project definition, the problematization time was useful for preparing the operational

work. The way the research questions were formulated pre-defines the field work priorities and availability of every actor.

- *Deadline type:* scientific deadlines, media deadlines

It was found that scientific deadlines were longer than journalistic deadlines, often set within 1, 3 or 5 days.

- *Time sequence* between project writing, funding obtention and field work: long, short AND as planned, unexpected

Important delays were experienced between one phase and another one, for example receiving the funding- These delays preconfigure the availability of actors for working immediately. In the mid-time actors are working in parallel with other projects or tasks related to their own occupation.

- *Exchange intensity:* sporadic, frequent
- *Exchange modality before work*: physically, in remote AND individually, together
- *Procedure to work:* individually, together AND same time, in different times
- *Ways of prioritizing tasks*: individually, together AND common tasks, different tasks

While work is punctual and sporadic during the project writing, collaboration becomes more intense when the field work starts. In addition, the time when every project step takes place influences the availability of every actor according to its modality.

Final production activities

- *Publication / Dissemination time*: quick, long AND during the project, after the project AND common time, different time for every actor
- *Availability:* during the project, after the project AND immediate, 1 to 3 days, 1 week
- *Intervention mode during production*: during, after AND one-shot, iteratively, only validation AND synchronous-physically, asynchronous-online
- *Reactivity in production phase:* immediate, delayed
- *Quantity of products in production*: limited, several

The time for publishing or disseminating the results of the project organizes the way actors can work together, as well as the quantity of products to produce. While journalists are used to working in short-time periods and expect reactivity from researchers, the latter is used to longer periods for analytical tasks. In addition, journalists prefer having more freedom by receiving a posteriori feedback on their production, and without a final validation. On the contrary, researchers prefer iterative discussions and revisions, with a final validation before publication. The ultimate challenge for journalists was to dedicate more time for working collaboratively in different sequences and not only requesting a work load in a given time. A final observation was that publications can often take place after the project ends which requires additional availability unpaid from actors.

- *Dependence in operational relationship:* individual tasks, common tasks AND independent

tasks, dependent tasks

- *Written collaboration type:* alone, together AND individual project, common project

Actors can work in different modalities according to the relationship of dependence they establish. However, when these modalities are not established between actors, one person can take the initiative to assume some tasks without the contribution of others. Moreover, when actors have individual or common production tasks their availability can be restrained.

- *Third-party operational dependence for producing:* superior chef, sponsor, partner

The relationship between the researchers and journalists depends additionally on the third-party involved. Journalists could not overcome their responsibilities vis-à-vis superiors for producing beyond the agreements with the researcher.

- *Product format*: audio, audiovisual, media article, scientific article

- *Deadline coordination of products:* simultaneous, in sequence

The product format defined in the project was really important for the task distribution (who does what and how), as well as for planning the delays between actors.

- *Role assigned to produce*: expert (analytical), reporter

Researchers were assigned as experts which determines the moment and type of contribution they have to give in the project.

The concrete operationalisation of concepts and comparative observations into quantifiable criteria drawn from PLACES concludes our state of the art. While multiple definitions and criteria can be identified in the literature, it is a necessary step to formalize the process for establishing cooperation analytics. The formalisation we make is based on the development of a monitoring grid as explained above.

IV. Cooperation Analytics Monitoring Grid

Previous studies on cooperation lack indicators that enable social actors to evaluate their own practices within citizen science projects in a non-normative way without competition. As stated by Farnell (2021), who presents the project "Towards a European Framework for Community Engagement in Higher Education" (TEFCE) and its role in the development of a European framework for community engagement: "assessment of community engagement should be an institutional learning journey rather than a narrow performance assessment". [3]

Based on the state of the art about the definition of cooperation, sections IV and V present our operationalisation of cooperation analytics as a monitoring grid for practitioners. The cooperation analytics are developed in two steps: First, we present the conceptualisation of the monitoring grid based on the previous interdisciplinary literature review. Second, we develop a new cooperation typology that will enable actors to understand and embrace the plurality of their cooperation practices based on the compass method (Boullier, 2003). This cooperation typology does not intend to position a Pilot project into a specific box. It rather allows actors to identify the proportion, balance and degree of the different types of cooperation they might develop throughout their collective learning process, and that ultimately actors can modify if they consider it necessary. Finally, we present the monitoring grid's computable translation (i.e., Its concrete calculation process within a software program), consisting of the construction of indicators and the data collection. The operationalisation will enable VERA designers and developers to understand more concretely how VERA will integrate the definition and construction of indicators we created. More specifically, it guides on what data is collected, at what precise moment of the process, how it will be aggregated or not with other data and the methods of analysis.

Conceptual Monitoring Grid

Before presenting the conceptual monitoring grid, we provide guidance on the full process of conceptualisation and operationalisation of cooperation analytics that we conducted.

- 1/ cooperation features were identified from the literature and translated into real practices of actors.
- 2/ a cooperation typology was defined from the literature and adapted in relation to the features selected.
- 3/ the features enabled us to define four categorical values, one for each of the four cooperation types: adaptive, plan oriented, institutional, revision-based. This typology will be used later for data visualization purposes, as a guidance to actors indicating the results of the cooperation analysis.
- 4/ from the cooperation typology it was possible to define the indicators that enable actors more concretely to measure their activity on the platform. Every indicator measures a feature defined in the typology.
- 5/ every indicator is constructed in an aggregated or simple way according to the data

[3] Source: https://blogs.lse.ac.uk/impactofsocialsciences/2021/07/12/an-alternative-approach-to-measuring-community-engagement-in-higher-education/

that can be collected in the VERA platform or in external platforms used by the actors.

We represent the conceptualisation and operationalisation process as follows:

> Cooperation **Features** according to the literature -> **Cooperation typology** according to the literature and our model -> **Categorical values** defined for the Cooperation Typology -> **Indicators** constructed in relation to the features -> **Data** (or traces) to collect for constructing the indicators

Cooperation Features

The first step is the conceptualisation of features. The features we propose belong to three analysis levels as presented in the introduction (WP5 scope and purpose within COESO). These levels are internal quality, process quality and external quality. Within internal quality, we identified two subgroups of analysis: individual profile, organizational profile. It is important to note that we limited the number of features corresponding to the individual profile (e.g., name) as these features might create risks of surveillance and penalties on actors. We want to avoid the identification and tracking of specific users on the platform. Instead, users can evaluate their projects as a whole. The cooperation analytics' main goal is to provide a view on the cooperation as a collective work, and not individually.

28 cooperation features were defined and they belong to different definitions of cooperation in the bibliography.

Skills: individual and organizational (No. 1, 3), are a main source of contribution within citizens and researchers' practices. According to Millerand (2021), it is commonly observed that while citizens provide experiential skills, researchers provide technical skills. The latter are often the only actors considered as experts.
Culture diversity: individual and organizational (No. 2, 4), are important elements that define in advance the cooperation possibilities. The diversity relies on the multiple disciplines involved in the project, and on the actors' professional and experience background.
Ways to obtain data sources (No. 5): data is a major element for analysing citizen science participation, often expected to be collected and labelled by citizens for science. While some authors call this a passive form of participation, others consider it key in citizen science, in particular in life sciences. More broadly, the way data are obtained characterises the organizational profile for cooperation.
Citizen/Research compensation (No. 6). The compensation of actors influences the development of cooperation practices and the possibilities of engagement. The formalisation of the compensation also defines the time that can be dedicated to the project.
Main type of funding (No. 7): While citizen science research is increasing, the allocated funds can come from multiple sources. The funding acquisition organizes the cooperation availability and investment that can be given.
Results dissemination type (No. 8): is a main element for evaluating cooperation in the literature: the products to deliver in the project and its dissemination process. It is an important phase for knowledge production.
Methods for recruiting citizens/researchers (No. 9). Literature shows that the way actors are recruited can, more or less, formalise the cooperation practices and the expectations for each party involved.
Device specificity (No. 10): the technology used for developing projects, as well as

communication tools for the cooperation development characterise the possibility of including citizens in the scientific practices.

Organization of citizen/science participation (No. 11). It defines the type and configuration of actors' participation for cooperating in the project.

Flow of citizen/research participation (No. 12). The flow refers to the process characterised in quantity and the intensity of the actors' participation in cooperating.

Rhythm of citizen/research participation (No. 13). It adds to the process analysis the pace, frequency and duration, of the actors' contribution for cooperating in the project within a timeline.

Distribution of roles in scientific/citizen participation (No. 14): the role or status of actors in the project configures the direction of contributions distributed among the parties involved.

Conflict and problem solving (No. 15). Management literature and pragmatic sociology pay particular attention to conflict and problems as important activities to identify by managers, and more broadly to overcome (as tests) by actors in coordination. The feature tackles the formalisation of these unavoidable activities for actors to cooperate.

Networking method and quality (No. 16, 17) describes the creation of a social structure and its dynamic evolution for creating stable and new cooperative situations.

Governance principles (No. 18) is mainly based on Boltanski and Thévenot's (2006) reference "The orders of worth" for describing the principles that guide the cooperation practices. Other authors in the citizen science literature have highlighted the relevance of principles in organizing communities of practice.

Idiom management (No. 19) enables us to detect the idiomatic tension and flexibility of actors considered when communicating with others in different media.

Knowledge diversity processing (No. 20) enables us to detect the idiomatic tension and flexibility of actors considered within knowledge production processes when cooperating for producing a result (e.g. writing a report, an article).

Knowledge exchange orientation (No. 21): social exchange and knowledge production are often considered in the cooperation evaluation. They constitute a key element for establishing trust, which ultimately leads actors to decide to cooperate or not. We combine these criteria to focus on the orientation of the knowledge exchange in cooperation. In other words, how much actors balance their contributions to others.

Management style (No. 22). It describes the managers' communication forms adopted and the type of feedback provided to others, which can more or less stimulate cooperation. The style is relevant in the literature of cooperation as it configures the community of practice.

Division of labor (No. 23): the functional differences of actors within the project organization relate to the cooperation tasks that can be performed individually or together between citizens and researchers.

Data articulation mode (No. 24) refers to the flow or process of managing data accessibility and sharing within teams and with external actors.

Stakeholder and data scalability (No. 25). As previously mentioned, data often constitutes a starting point, and a major interest for citizen science projects. Stakeholder and data scalability refers to the capital accumulated and its complexity for creating shared goals with different actors or institutions.

Learning process (No. 26): cooperation achievement is often defined by the capacity of actors to learn in action, as well as by their capacity to revise their actions. This feature refers more particularly to the way actors and actions are assessed continuously.

Engagement assessment type (No. 27): one factor that defines citizen science participation is the level of engagement of actors, also called "activeness". This feature focuses on the own indicators or quality criteria defined within the Pilots to assess the project results and the actors.

Legal and ethical compliance (No. 28). The feature refers to legal and ethical codes, as explicit conventions, to which actors need to comply for data, infrastructure and management.

Analysis level	No.	Cooperation Features	Operationalised from
Internal quality: Individual profile	1	Skills	(Chibois et Caria, 2020; Haklay et al. 2021; Morillon, 2021)
Internal quality:Individual profile	2	Culture diversity	(Eaton, 1948; Haklay et al. 2021)
Internal quality: Organizational profile	3	Collective skills diversity	(Chibois et Caria, 2020; Haklay et al. 2021; Morillon, 2021)
Internal quality: Organizational profile	4	Collective cultural diversity	(Eaton, 1948; Haklay et al. 2021)
Internal quality: Organizational profile	5	Ways to obtain data sources	(Chibois et Caria, 2020)
Internal quality: Organizational profile	6	Citizen/Research compensation	(Haklay et al. 2021; Shirk et al., 2012)
Internal quality: Organizational profile	7	Main type of funding	(Chibois et Caria, 2020)
Internal quality: Organizational profile	8	Dissemination type of results	(Chibois et Caria, 2020; Shirk et al., 2012)
Internal quality: Organizational profile	9	Methods for recruiting citizens/researchers	(Chibois et Caria, 2020; Shirk et al., 2012)
Internal quality: Organizational profile	10	Device specificity	(Haklay et al. 2021)
Process quality	11	Organization of citizen/research participation	(Millerand, 2021; Chibois et Caria, 2020)
Process quality	12	Flow of citizen/research participation	(Millerand, 2021; Liu, 2008; Eaton, 1948; Neale et al., 2004; Haklay et al. 2021; Shirk et al., 2012; Gongora et al. 2018)
Process quality	13	Rhythm of citizen/research participation	(Liu, 2008; Eaton, 1948; Chibois et Caria, 2020)
Process quality	14	Distribution of roles in scientific/citizen participation	(Eaton, 1948; Liu, 2008; Chibois et Caria, 2020; Haklay et al. 2021; Sanders and Schyns, 2006; Josserand, 2004; Shirk et al., 2009; Jamali et al., 2006)

Process quality	15	Conflict and problem solving	(Liu, 2008; Axelrod, 2006; Sennett, 2013; Sanders and Schyns, 2006; Jamali et al., 2006)
Process quality	16	Networking method	(Koster et al. 2007; Granovetter, 1985)
Process quality	17	Networking quality	(Koster et al. 2007; Sanders and Schyns, 2006; Granovetter, 1985)
Process quality	18	Governance principles	(Boltanski et Thévenot, 2006; Josserand, 2004; Morillon, 2021)
Process quality	19	Idiom management	(Boullier, 1984; Morillon, 2021)
Process quality	20	Knowledge diversity processing	(Chavalarias et Cointet, 2013; Chibois et Caria, 2020; Haklay et al. 2021; Morillon, 2021; Shirk et al., 2012)
Process quality	21	Knowledge exchange orientation	(Sanders and Schyns, 2006; Khawaji et al., 2013; Gongora et al. 2018; Morillon, 2021)
Process quality	22	Management style	(Josserand, 2004)
Process quality	23	Division of labor	(Koster et al. 2007; Eaton, 1948; Gongora et al. 2018)
Process quality	24	Data articulation mode	(Strauss, 1997)
Process quality	25	Stakeholder and data scalability	(Haklay et al. 2021)
Process quality	26	Learning process	(Livet, 1994; Josserand, 2004; Morillon, 2021)
Process quality	27	Engagement assessment type	(Haklay et al. 2021; Sanders and Schyns, 2006; Gongora et al. 2018; Tjosvold and Tsao, 1989 in Liu, 2008; Le Cardinal, et al., 1997)
External quality	28	Legal and ethical compliance	(Haklay et al. 2021;Le Cardinal, et al., 1997)

Table 1. Conceptual monitoring grid including level of analysis, cooperation features and related bibliographical references

Cooperation Typology

In this section, the second step of the monitoring grid operationalisation, we propose a map of the various types of cooperation that make sense in this specific situation of citizen social science. From our exploration of the literature about citizen science and about cooperation in organizations and interpersonal relationships as well, we extracted some dynamic tensions based on the features presented above. We use the compass model (Boullier, 2003) to address innovation issues in order to emphasize the pluralism of choices. In this compass, all types of cooperation are treated equally, with no normative judgement. The typification that results (the labelled types) is less important than the tension that is documented precisely on some specific features of cooperation that gives room for each specific project to combine different types in their own way. The tension is represented in two axes: Axis *x* refers to the cooperation duration,

axis *y* to the level of formalisation in the cooperation.

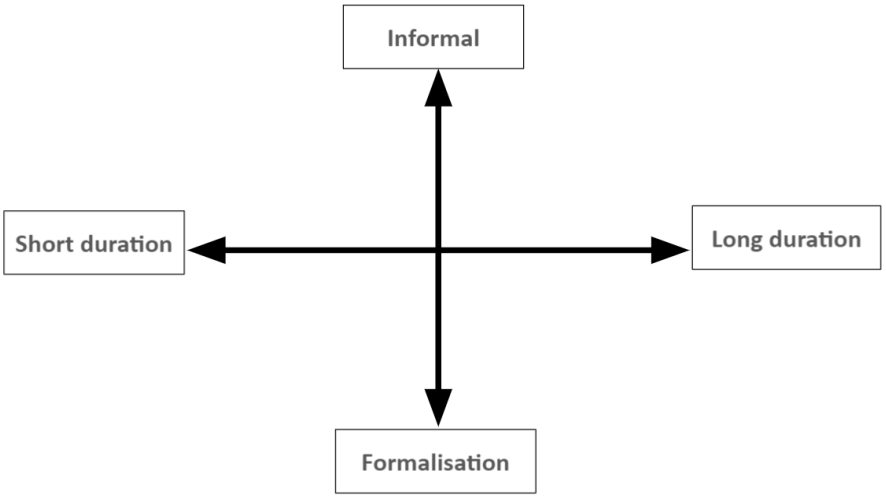


Image 1. Compass method designed for cooperation in two axes: duration and formalisation.

The first tension is the one between *short term and long term cooperation* in axis *x* (duration). Duration is something that the theories of choice and the evolution of cooperation (Axelrod, [1984] 2006) have well documented. As in the prisoner' dilemma, the number of turns plays a role in the way the participants can learn from each others' behavior. And a long term or supposedly infinite number of moves (of cooperative /defective acts) improve to a large extent the chances of adopting the cooperative behavior by participants. This must be considered as a distinctive feature of projects in citizen science, while it does not mean that short term style of projects cannot reach a significant level of cooperation. However, it makes sense to anticipate the higher investment required to assess each other and understand each other when a project is one-shot as opposed to a regular basis cooperative activity. On the other hand and to be sure that the balance is well maintained between all these different styles, one could argue that these repetitive and instituted projects may become more ritual and rigid and lacking some flexibility since routines would dominate. This situation is exemplified and formalised by Richard Sennett in his book "Together", where he put the emphasis on what he calls the "ritual" part of cooperation. It means that any project may introduce a part of ritual and even should be aware of the need to do so in order to gain some stability and to naturalize the relationships.

The other tension in axis *y* is focused on the level of formalisation of cooperation. When formalising the rules, the protocols and its rhythm, a cooperative assemblage gains many guarantees and certainties. This is supposed to be a good climate for cooperating, and it is an important effect of "conventions" (Eymard-Duvernay, 2006), that require careful description of roles, division of labor and explicitation of expectations. On the opposite side, any project must develop some tolerance to uncertainty or it would become just the implementation of a predesigned plan which is not realistic especially in our environments of social issues. But some stakeholders may favor more formalisation while others may feel more comfortable with adaptation to circumstances (i.e., a low level of formalisation), to the point that the whole project may become opportunistic, while missing its previously established goals. Due to this low formalisation, the participation of citizens can be facilitated in some cases with scientists who

are trained into the respect of procedures, from data collection to validation of hypotheses and interpretation. However, cases may differ a lot in social sciences since social scientists are often criticized for a lack of formalism and robustness in their arguments.

The combination of both axes can deliver a four quadrant view of the cooperation opportunities and styles that is clearly a way to amplify the differences, for the sake of the style elicitation based on features. It should not be considered as a realistic rendering of the types of projects we can observe. However, by adopting the polarization method we can offer a dramatic tension between the poles of the compass that is realistic enough from the stakeholders' point of view on their experiences. Some cooperation types insist more in the formalisation dimension, others on a long duration. Depending on the project stage, one can observe a change in these positions. The combination of axes leads to four types of cooperation that are defined in the next subsection:

- Adaptive
- Plan oriented
- Institutional
- Revisable

In order to describe these cooperation types we did not try to classify the existing COESO Pilots because our goal is to help the participants make their own balance among these tensions. What we shall do by offering cooperation assessment is to display indicators that are expressing the features of these axes, so that stakeholders can monitor their own activity on a permanent basis. We put forward a transparency value so actors know the way indicators are constructed: they will know explicitly how these indicators are designed and weighted. As mentioned previously, we are aware that these measures can influence the way actors analyse their performance. Indeed, once actors learn how they are being evaluated online, they could put in place dynamics to change their score (Pidoux, 2021) or to ensure that a cooperation type is displayed, which is not a type that reflects their real tendency. However, the cooperation analytics we defined are not conceived for judging or ranking the individual characteristics, their actions, or their projects along a unique scale. We avoid the use of rankings as a standard for excellence which does not allow actors to have a reflexivity on their projects. We avoid defining one type of excellence that is accepted and computed as many platforms are doing today, within the broad ranking phenomena. The different features of cooperation will be calculated from data or traces (metadata and text mining) so that users declare very little via online forms or interviews: their own behavior on the platform will be sufficient to extract the necessary data for the majority of indicators.

It is important to note that the previous definition of a list of cooperation features was an essential task for the cooperation analytics because it is intended to be closely connected to the real activity of participants. At this stage, these cooperation features are mainly conceptual. We selected and operationalised them from the literature review and we will test their feasibility before we try to implement them.

Four Cooperation Types: Definition

Adaptive cooperation

The adaptive cooperation type is reactive, ephemeral or short term and it is highly adaptable to

the circumstances as they arise. Actors in adaptive cooperation take advantage of opportunities as they occur to achieve an end in accordance with situations and not according to a plan.

Plan oriented cooperation

The plan oriented cooperation type is driven by a plan, the results that can be obtained and the indicators that measure them. Actors in the plan oriented cooperation follow explicit actions with a focus on the goal to achieve.

Institutional cooperation

The institutional cooperation type is organized by tacit and repetitive actions that become habits. Actors in the ritual cooperation integrate conventions into their daily working practices with others for building loyal practices. The conventional actions followed by actors are supposed to be recognized and legitimate by the collectivity.

Revisable cooperation

The revisable cooperation type is evolving and does not take for granted the plan. Instead, it is based on the iterative evaluation and negotiation of practices. Actors are in continuous learning, they control and overcome the situations that arise to update the plan and finally review its coherence with others.

Compass Typology

The cooperation types are now graphically presented in the compass (Image 2). The types are positioned in the four quadrant view of the cooperation opportunities and styles to demonstrate their opposition. In the *x* axis one can find the duration, in the *y* axis one can find the formalisation.

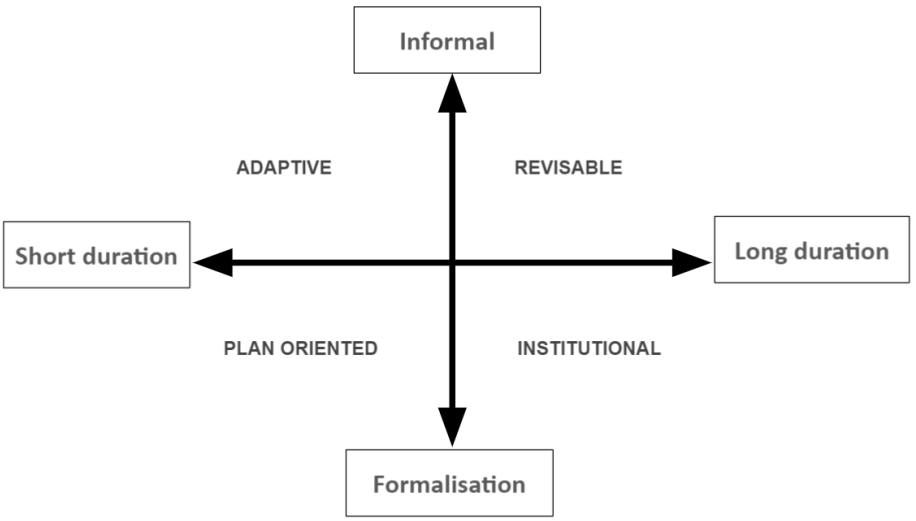


Image 2. Compass of the cooperation typology

These are only ideal types that will not be found in real life settings. The principle of generating clear-cut oppositions in this way resembles the oppositions produced by Support vector machines (SVMs). SVMs are a set of supervised machine learning methods used for classification, regression and outliers detection, in which clusters have to be separated with as vast margins as possible to be comparable. The clear-cut oppositions that we make manually help demonstrate the polarities and the tension that trigger cooperation practices but real projects are always a composite arrangement between these solutions. This model helps us with the variety of choices available and to be sure that we do not get trapped into one and only one style of cooperation. Participants will obtain enough feedback and levers of action so that they can anticipate the evolution of the project and take corrective action on time if they wish.

V. Cooperation Analytics: Operational Monitoring Grid

The operational monitoring grid refers to the way the conceptual monitoring grid previously presented can be actually computable and implemented in the VERA platform (Table 2). The operationalisation is made possible by two consequent activities: the definition of categorical values for characterising the cooperation types and the construction of indicators with its data collection.

Cooperation Typology: Categorical Values

We previously identified and defined four types of cooperation: adaptive, plan oriented, institutional, revisable, for embracing the plurality of Pilots' practices without being normative and creating absolute positions. In order to measure the proportion of every cooperation type in the Pilots, it is necessary to define beforehand how every cooperation feature relates to every cooperation type. For this purpose, we now define categorical values for each feature, creating this way a matrix (Table 2). This refers to the third step of the monitoring grid's operationalisation.

It is important to note that the revisable cooperation type is not documented as such. One justification is that we did not get enough field information to account for this style of cooperation for citizen science projects, while we observed many features related to other types in the currently existing Pilot projects. The second reason is that this quadrant is supposed to assemble the "best" solutions found by other types. We would like to pretend that we hope the VERA platform will demonstrate the feasibility of such a revision model of cooperation and will help support these trends in all Pilot projects. It should be considered as a future outcome of the Coeso project: to deliver not only a technical solution such as a platform but also the justification and the organizational recommendations that would help citizen science projects succeed.

The categorical values defined for each feature follow a principle of opposition. They do not seek to describe a continuum as did previous research (Millerand, xx). Instead, the values in each type and features are designed for describing the tension and the poles towards which the interaction can be oriented.

For instance, the feature "skills" presents the following categorical values depending on the style of cooperation adopted: experiential, academic-expert, procedural for adaptive, plan oriented and institutional respectively. The traditional way of exposing the skills relies on procedures, qualifications that are part of a systematic and administrative description of skills. For the plan oriented type, it is not an administrative description that is the most important but the qualification related to a specific expertise (academic or other professional expertise). By contrast, the adaptive style of cooperation may accept more experiential skills, obtained through very different types of experiences, from amateur training to personal life situations.

	Categorical Values according to Cooperation Typology			
Cooperation Features	**Adaptive**	**Plan oriented**	**Institutional**	**Revisable**
Skills	experiential	academic-expert	procedural	
Culture diversity	cultural mix	pluricultural	unique	
Collective skills diversity	experiential	academic-expert	procedural	
Collective cultural diversity	cultural mix	pluricultural	unique	
Ways to obtain data sources	snow ball	sampling	captive audience	
Citizen/Research compensation	incentives	contract	altruistic duty	
Main type of funding	crowdfunding	mixed	institutional	
Dissemination type of results	open	divided according to fields	academic oriented	
Methods for recruiting citizens/researchers	informal	call procedure	membership	
Device specificity	ad hoc assemblage	scientific and technical	standard compliant	
Organization of citizen/research participation	encounters	scheduled meetings	platforms	
Flow of citizen/research participation	spontaneous conversation	goal oriented conversation	asymmetric conversation	
Rhythm of citizen/research participation	burst	planned	continuous	
Distribution of roles in scientific/citizen participation	sharing	expert discussion	coaching	
Conflict and problem solving	arrangement	negotiation	procedural resolution	
Networking method	incrementation	ad hoc	already instituted	
Networking quality	diversification	specialization	simplification	

Governance principles	interpersonal	market industrial	bureaucracy	
Idiom management	polysemic tolerance	jargon translation	conventional language	
Knowledge diversity processing	conceptual creolization	correspondence and translation table	contribution to common knowledge	
Knowledge exchange orientation	egalitarian	differential	unidirectional	
Management style	support	stimulation	control	
Division of labor	ad hoc distribution	skill based	statut based	
Data articulation mode	data lake	data network	data workflow	
Stakeholder and data scalability	staggering	anticipated	stable	
Learning process	trial and error	scientific method	capitalization	
Engagement assessment type	proof of initiative	proof of work	proof of compliance	
Legal and ethical compliance	versatility	risk taking	certificated	

Table 2. Cooperation features and corresponding categorical values according to the cooperation typology

Indicator Construction and Data

In the citizen science field, “project managers as well as prospective funders are often at a loss when it comes to assessing and reviewing the quality and impact of citizen science activities” (Kieslinger et al., 2017). Citizens and researchers are also at a loss for evaluating their cooperation practices. The state of the art gives a clear view on the lack of indicators. We tackle this gap in COESO by constructing a set of indicators (Table 3), which is the fourth step of the monitoring grid operationalisation.

In this section we present the fourth step towards the operationalisation of the monitoring grid. Indicators measure the cooperation practices’ progress in respect with the features that define them, the cooperation typology and its corresponding categorical values previously presented. Indicators are used to assess the state of Pilot projects and the actions performed by Pilot members by defining the data to be collected, and then tracking changes over time.

We constructed the indicators in either a composite or a direct way. The composite indicator means that multiple data types are combined. On the contrary, the direct indicator relies on only one data type. The distinction is relevant as while the former requires a multidimensional analysis, the latter requires descriptive statistics. The next section presents in detail how the data is collected and calculated (Table 4). For instance, the indicator “collective diversity score” is a composite indicator as it combines three data types: localisation, disciplines, languages

spoken. We must remind the reader that we tried as much as possible to avoid any cognitive workload for the participants, this is why we did not ask any self assessment questions, any opinion survey. We favor automated collection of data from the traces of behaviours on the platforms and on other communication devices and from the documents written in the course of the collective activity. The only task that will rely on the contribution of participants is the personal and project profile they will fill up at the beginning of the project. This would clearly become a requirement for all the participants to any project on the platform but the features collected are not so numerous and the task not so heavy.

36 indicators were constructed, the full list is presented below (Table 3). Every indicator relates to a feature for indicating what it is measuring, and to every data type that can be collected for indicating how it can be measured.

Cooperation Features	Indicator	Data
Skills	Skill type	words to identify for every user and classify according to feature categories
Cultural diversity	Diversity score	number of disciplines for every user expertise in the project
		languages spoken by every user in the project
Collective skills diversity	Collective skill diversity	words to identify in the group conversation for all users involved and classify according to feature categories
Collective cultural diversity	Collective diversity score	localisation of every user in the project
		number of disciplines for every user expertise in the project
		languages spoken by every user in the project
Ways to obtain data sources	Sources mentioned in the project	text
Citizen/Research compensation	Level of recognition	words to identify "individual recognition" and classify according to predefined categories: authorship of every product, membership, acknowledgments, titles or badges in a platforms, gifts, has a contract yes or no
Main type of funding	Percentage of type of funding obtained for operations	funding source type
		funding amount
		number of funding sources
Dissemination type of results	Degree of field hybridation	text (e.g. final reports)
		who disseminates the product(s)
		where is (are) disseminated the product(s)
		what is the product type disseminated (scientific or not)
		what is the product format disseminated

Methods for recruiting citizens/researchers	Contractual formalism	recruitment mode for every user in the platform (see feature categories)
		contract time: task limited, short or medium-term, long-term
Device specificity	Device specificity degree	list of tools used
		type of tools used
Organization of citizen/research participation	Type of meeting	email subject
	Scale of meeting	number of participants invited
		number of participants present
	Medium of meeting	number of media used: identify zoom, google meet, etc.
Flow of citizen/research participation	Number of conversations and contributions	number of messages sent by medium (slack, email, etc)
		number of answers received / given
		number of modifications / corrections accepted / refused in the documents
		Active time spent in the platform (minutes)
		number of sessions (login)
		sessions' duration
		uploads in the platform
		downloads from the platform
		document views
		page visits
	Intensity of conversations and contributions	number of answers received / given
Rhythm of citizen/research participation	Frequency of conversations and contributions	timestamp of messages received / given
		answer delays
	Frequency of meeting	number of scheduled meetings
		number of unscheduled meetings
		timestamp of meetings done
		meeting duration
Distribution of roles in scientific/citizen participation	Degree of asymmetry	direction of exchanges: number of messages sent by first sender id
		number of messages received by first receiver id
		number of messages by any other different sender and receiver Ids
		number of characters in the message
		role of first message sender

		is the first sender a stakeholder in command
		total number of messages exchanged
	Contribution type	words to classify in predefined categories: substantial, phatic, managerial
Conflict and problem solving	Formalism degree of problem solving	number of ticket opening (zero means no formalism, possible accountability when formalism exists)
	Problem solving efficiency	number of ticket-problem closed
		delay between opening and closing a ticket
		number of iterations before closing a ticket
		number of contributors to the ticket problem solving
		number of tickets reopened with topic detection, to check if its the same topic explicit or implicit (mail object, sender)
		number of iterations
		delay before closing a ticket
Networking method	Evolution of network size	increase in the number of stakeholders
Networking quality	Network diversity	number of accounts created
		type of stakeholders in command (Who is the leader): amateur, academic, civil society via NGO's
		main type of result expected (scientific articles, etc.)
Governance principles	Social world balance	lexicon related to "Orders of worth"
		type of words
		weighting the type of words in the beginning, in the middle and at the end
Idiom management	Idiom diversity degree	text
Knowledge diversity processing	Knowledge convergence degree	concepts used in the products, specific lexicon related to every discipline
Knowledge exchange orientation	Knowledge distribution balance	detecting new terms (concepts, topics)
		who introduces new terms (concepts, topics)
		who reproduces new terms (concepts, topics)
		who makes suggestions
		who accepts suggestions
Management style	Manager style	identify informal influential users

		identify explicit leaders / managers
		identify lexicon related to management operations
	Manager balance	meetings metadata (e.g. participants in meeting)
		feedback metadata
Division of labor	Plan work organization	explicit organizational work
		organizational work official revision
		organizational work drifting
Data articulation mode	Documentation flow management	data storage
		access control
		management procedure
Stakeholder and data scalability	Increase of stakeholders	number of stakeholders throughout time: who creates accounts
	Increase of data volume	data volume acquisition throughout time
		number of data sources available
Learning process	Degree of collective assessment	results declared in comparison with results reported
		justification of results
		milestones, results expected, quality criteria defined
	Assessment style score	detect assessment terms
		detect assessment timestamp
		detect decision terms
		detect decision timestamp
		detect milestones terms
Engagement assessment type		are there indicators in the project
		identify expressions of assessment
		semantic properties of assessment (e.g. delays, respect)
		is quality semantic repertoire present
		identify semantics of quality (e.g. initiatives taken, creativity)
Legal and ethical compliance	Legal and ethical compliance score	data management plan created
		infrastructure compliance with DMP
		open data repository
		GDPR or applicable law compliance
		gender balance

Table 3. Indicators and corresponding data according to cooperation features

Methods and Data

This section presents the final step of the monitoring grid operationalisation. It is of particular use for designers and developers of the VERA platform as it explains in detail the methods of analysis, the data collection moment, and the data sources where to specifically obtain the data. It is important to note that at this stage, the operationalisation is at its initial stage based on the literature and on the preliminary observations made on the Pilots. The operationalisation is intended to evolve according to a revision phase with the Pilots and to VERA's development plan.

First, there are four main general methods of analysis identified: qualitative analysis, NLP (Natural Language Processing), multidimensional analysis and descriptive statistics.

The qualitative analysis is required when collecting data from interviews and observations, for instance, the project proposal and the first reports that the Pilots have produced without the existence of the VERA platform.

NLP is required for analysing a large corpus of text in the written exchanges and the written productions made by Pilots. The bag-of-words model (Zhang et al., 2010) will be particularly useful for the "idiom management" and the "knowledge exchange distribution" features. In simple words, the technique consists of a representation of a text that describes the average occurrence of words within a document.

The multidimensional analysis is required for the composite indicators constructed as they account for multiple data types.

Finally, the descriptive statistics are used for simple indicators that are based on a simple count or sum of events, e.g. the duration of meetings.

Second, data are going to be collected at three different moments: (i) **declarative upstream** when registering in the platform users have to fill in information in a profile page, (ii) **on-going** when actions are already taking place in the platform on a regular basis, (iii) **declarative downstream** when users of the platform are requested to provide a final feedback on their projects, mainly through surveys we will design. While the declarative data is entered by the user explicitly, the on-going data refers to implicit data provided in the platform from user activity.

Finally, data comes from three main sources we identified: (i) a **profile page** previously designed in VERA, (ii) **activity logs** from the user activity in the platform directly linked to the VERA functional development. If possible, activity logs from external platforms as we observed Pilot activities happen commonly across various platforms, (iii) text mining from **written content** produced in different media and supports -in VERA or externally- like messaging, emails, meeting minutes, other activity reports produced and final products (scientific papers, press articles, etc.)

At this stage, as mentioned, Pilots use different platforms to conduct their projects and some of the platforms used are not going to be replaced by the VERA functionalities. This observation is relevant to consider during the functionalities development of VERA. Indeed, the matchmaking functionality of GOTRIPLE, the recommender system, messaging and funding integrated services are important features for Pilots but VERA must provide an attractive operational activity so that users actively engage within the platform without requesting additional tasks to Pilots. An additional functionality to attract users to the platform could be that VERA strengthens the processes of assessment and learning into the platform. Thus, VERA will be a landmark for actors to follow up their *learning journey*: how they are evaluated from their specific standpoint and not from a standard one, what is expected as a result, what is the quality criteria set up and

most importantly, how they can receive continuous feedback on their work which leads to a follow up process of their engagement. As of today, Pilot members have expressed the little feedback received in past projects and the lack of quality criteria for assessing their work.

Indicator	Method of analysis	Data collection moment	Data	Data sources
Skill type	NLP	On-going	words to identify for every user and classify according to feature categories	message content
Diversity score	multidimensional analysis	Declarative upstream	number of disciplines for every user expertise in the project	profile page
		Declarative upstream	languages spoken by every user in the project	profile page
Collective skill diversity	NLP	On-going	words to identify in the group conversation for all users involved and classify according to feature categories	message content
Collective diversity score		Declarative upstream	localisation of every user in the project	profile page
		Declarative upstream	number of disciplines for every user expertise in the project	profile page
		Declarative upstream	languages spoken by every user in the project	profile page
Sources mentioned in the project	qualitative analysis	Declarative upstream	text	project proposal
Level of recognition	qualitative analysis	Declarative upstream	words to identify "individual recognition" and classify according to predefined categories: authorship of every product, membership, acknowledgments, titles or badges in a platforms, gifts, has a contract yes or no	project proposal, interviews
Percentage of type of funding obtained for operations	multidimensional analysis	Declarative upstream	funding source type	profile page
			funding amount	profile page

			number of funding sources	profile page
Degree of field hybridation	NLP	Declarative downstream	text (e.g. final reports)	NLP
	multidimensional analysis	Declarative downstream	who disseminates the product(s)	survey
		Declarative downstream	where is (are) disseminated the product(s)	survey
		Declarative downstream	what is the product type disseminated (scientific or not)	survey
		Declarative downstream	what is the product format disseminated	survey
Contractual formalism	multidimensional analysis	Declarative upstream	recruitment mode for every user in the platform (see feature categories)	profile page
		Declarative upstream	contract time: task limited, short or medium-term, long-term	profile page
Device specificity degree	multidimensional analysis, qualitative analysis	Declarative upstream	list of tools used	profile page, project proposal, interviews
			type of tools used	profile page, project proposal, interviews
Type of meeting	descriptive statistics	On-going	duration, email subject	activity logs, calendars, emails
Frequency of meeting	multidimensional analysis	On-going	number of scheduled meetings	activity logs, calendars, emails
		On-going	number of unscheduled meetings	activity logs, calendars, emails
		On-going	timestamp of meetings done	activity logs, calendars, emails
Scale of meeting	multidimensional	On-going	number of participants invited	activity logs, calendars, emails

	analysis			
		On-going	number of participants present	activity logs, calendars, emails
Medium of meeting	descriptive statistics	On-going	number of media used: identify zoom, google meet, etc.	activity logs, calendars, emails
Number of conversations and contributions	multidimensional analysis	On-going	number of messages sent by medium (slack, email, etc)	activity logs
		On-going	number of answers received / given	activity logs
		On-going	number of modifications / corrections accepted / refused in the documents	google docs
		On-going	Active time spent in the platform (minutes)	activity logs
		On-going	number of sessions (login)	activity logs
		On-going	sessions' duration	activity logs
		On-going	uploads in the platform	activity logs, google drive
		On-going	downloads from the platform	activity logs, google drive
		On-going	document views	activity logs, google drive
		On-going	page visits	activity logs
Intensity of conversations and contributions	descriptive statistics	On-going	number of answers received / given	activity logs
Frequency of conversations and contributions	multidimensional analysis	On-going	timestamp of messages received / given	activity logs
		On-going	answer delays	activity logs
Degree of asymmetry	multidimensional analysis	On-going	direction of exchanges: number of messages sent by first sender id	profile page

		On-going	number of messages received by first receiver id	profile page
		On-going	number of messages by any other different sender and receiver Ids	profile page
	NLP	On-going	number of characters in the message	message content
		On-going	role of first message sender	profile page
		On-going	is the first sender a stakeholder in command	profile page
		On-going	total number of messages exchanged	activity logs
Contribution type	NLP	On-going	words to classify in predefined categories: substantial, phatic, managerial	message content
Formalism degree of problem solving	descriptive statistics	On-going	number of ticket opening (zero means no formalism, possible accountability when formalism exists)	activity logs
Problem solving efficiency	multidimensional analysis	On-going	number of ticket-problem closed	activity logs
		On-going	delay between opening and closing a ticket	activity logs
		On-going	number of iterations before closing a ticket	activity logs
		On-going	number of contributors to the ticket problem solving	activity logs
	NLP	On-going	number of tickets reopened with topic detection, to check if its the same topic explicit or implicit (mail object, sender)	message content
		On-going	number of iterations	activity logs
		On-going	delay before closing a ticket	activity logs

Evolution of network size	descriptive statistics	Declarative upstream, on-going	increase in the number of stakeholders	activity logs
Network diversity	multidimensional analysis	Declarative upstream, on-going	number of accounts created	activity logs
		Declarative upstream, on-going	type of stakeholders in command (Who is the leader): amateur, academic, civil society via NGO's	profile page
		Declarative upstream, on-going	main type of result expected (scientific articles, etc.)	profile page
Social world balance	NLP, bag of words	On-going	lexicon related to "Orders of worth"	messaging service flow, documents, meeting minutes, any other written text, google docs
			type of words	
			weighting the type of words in the beginning, in the middle and at the end	
Idiom diversity degree	NLP	On-going	text	messaging service flow, documents, meeting minutes, any other written text, google docs, social media
Knowledge convergence degree	NLP	At the end of project	concepts used in the products, specific lexicon related to every discipline	papers in general, scientific articles, press media
Knowledge distribution balance	NLP	On-going	detecting new terms (concepts, topics)	message content in document versions, google docs, papers in general, scientific articles, press media
		On-going	who introduces new terms (concepts, topics)	message content in document versions, google docs, papers in general, scientific articles, press media

		On-going	who reproduces new terms (concepts, topics)	message content in document versions, google docs, papers in general, scientific articles, press media
		On-going	who makes suggestions	message content in document versions, google docs, papers in general, scientific articles, press media
		On-going	who accepts suggestions	message content in document versions, google docs, papers in general, scientific articles, press media
Manager style	NLP	On-going	identify informal influential users	minute meetings, messaging services
		Declarative upstream	identify explicit leaders / managers	profile page
	NLP	On-going	identify lexicon related to management operations	minute meetings, messaging services
Manager balance	multidimensional analysis	On-going	meetings metadata (e.g. participants in meeting)	activity logs, calendar
		On-going	feedback metadata	activity logs, minute meetings
Plan work organization	qualitative analysis	Declarative upstream	explicit organizational work	project proposal
	multidimensional analysis	Declarative downstream	organizational work official revision	minute meetings, papers produced, final reports
	multidimensional analysis	Declarative downstream	organizational work drifting	survey
Documentation flow management	multidimensional analysis	Declarative upstream and downstream	data storage	profile page
		Declarative upstream and	access control	profile page

		downstream		
		Declarative upstream and downstream	management procedure	profile page
Increase of stakeholders	descriptive analysis	Declarative upstream, On-going	number of stakeholders throughout time: who creates accounts	profile page, activity logs
Increase of data volume	multidimensional analysis	Declarative upstream, On-going	data volume acquisition throughout time	profile page, activity logs (if tasks are integrated in the platform), external data
		Declarative upstream, On-going	number of data sources available	profile page, activity logs (if tasks are integrated in the platform), external data
Degree of collective assessment	NLP	Declarative upstream, On-going, Declarative downstream	results declared in comparison with results reported	meeting minutes, final reports, products
	NLP	Declarative downstream	justification of results	final reports, products
	multidimensional dimension	Declarative upstream	milestones, results expected, quality criteria defined	profile page
Assessment style score	NLP	On-going	detect assessment terms	messaging services, meeting minutes, final reports, products
		On-going	detect assessment timestamp	messaging services, meeting minutes, final reports, products
		On-going	detect decision terms	final reports, minute meetings
		On-going	detect decision timestamp	final reports, minute meetings
		On-going	detect milestone terms	final reports, minute

				meetings
	NLP	On-going	are there indicators in the project	messaging services, emails, minute meetings
		On-going	identify expressions of assessment	messaging services, emails, minute meetings
		On-going	semantic properties of assessment (e.g. delays, respect)	messaging services, emails, minute meetings
		On-going	is quality semantic present	messaging services, emails, minute meetings
		On-going	identify semantics of quality (e.g. initiatives taken, creativity)	messaging services, emails, minute meetings
Legal and ethical compliance score	multidimensional analysis	Declarative upstream and downstream	data management plan created	profile page
			infrastructure compliance with DMP	profile page
			open data repository	profile page
			GDPR or applicable law compliance	profile page
			gender balance	profile page

Table 4. Methods of analysis, data collection moment, data, data sources according to indicators

Data Visualization in VERA Dashboard

Five types of possible visualization are discussed in this section. The graphical representation of the cooperation analytics monitoring grid into VERA may provide social actors a view on their type of cooperation. This is the condition for the cooperation analytics to be adopted by the participants. The visual presentation of indicators delivers a synthetic message that must be designed as accessible by all members of a project with a minimum cognitive workload. However, our orientation in favor of a pluralist set of indicators depending on the style of cooperation each project wants to adopt is rather compelling and may create some obstacles for the uptake we are looking for. This is part of our challenge and commitment, to find the right balance

between these requirements.

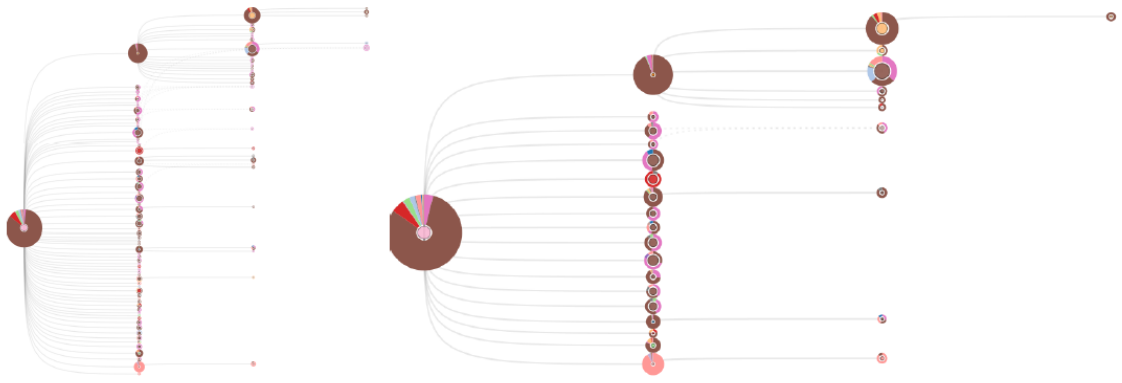
The types of visualization discussed are:

- network analysis,
- radar chart with scale or without scale,
- radar chart in percentage
- heatmap.

Currently, the radar chart remains the most favorable option. Another option is presented which is taken from a real case of analytics representation implemented on Slack. A final option, the heatmap, is presented from an European project on community engagement in higher education.

Network analysis

A powerful approach for visualizing while measuring cooperation is the social network analysis (SNA) transposed into a visualization of a graph. One study defines cooperation within social network platforms with a high number of actors and type of content involved in the process. Cooperation here is limited to the link and interactions between users. More specifically, Cazabet and Takeda (2014) define a cooperation flow and its visualization with a longitudinal perspective by means of number of videos, number of views in the videos, date of publication, tags associated and considered as attributes, comments written. The authors' contribution is to simplify the visual appearance of the network by deleting transitive links that do not add information to the cooperation with a timeline presented from left to right (Figure 2), adding information to the nodes (Figure 3) and filtering the nodes for better readability based on computing "a cooperation impact value, which represents how strong is the impact of a node in the global cooperation flow'' Cazabet and Takeda (2014, p. 209).



(a) Original cooperation flow (b) Cooperation flow filtered to keep only 30 nodes

Figure 2: Effect of filtering nodes

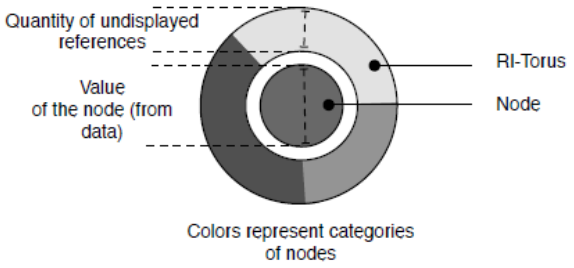


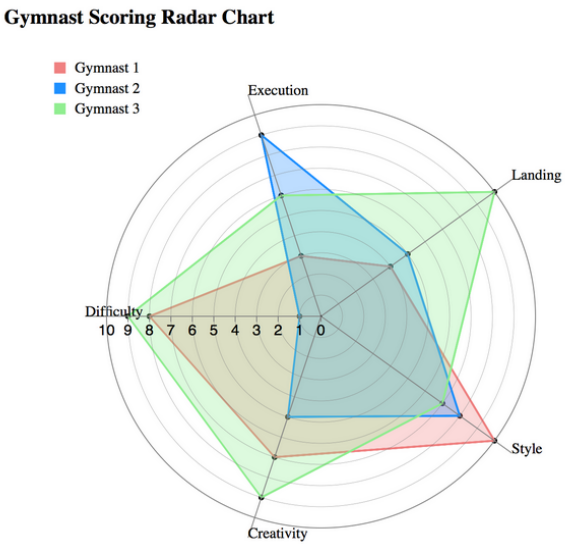
Figure 3: Schema of the representation of a node

Broadly speaking, the authors propose to reduce the reality that is represented in networks (in terms of data points) and favor the construction of indicators that provide content on the connection that is represented. From this reference we retain the relevance of the longitudinal analysis, the readability of interactions in a graphical visualization and the possibility of integrating our indicators into a representation of the cooperation typology. For instance, within a spatial compass representation, an indicator can help place the project within a type of cooperation located in the compass.

Radar chart with scale or without scale

The radar chart is a suitable visualization for representing the cooperation typology defined for the cooperation analytics. The advantage is that the variety of features becomes accessible at a glance and still precisely measurable.

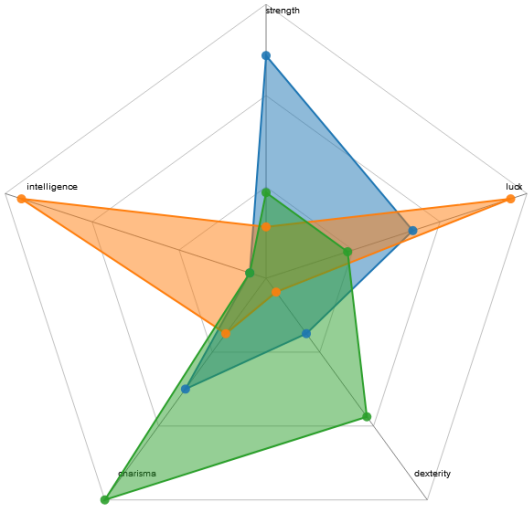
The option with scale presents some limitations related to the robustness and precision of the scales that are used. This is a requirement we are aware of when designing the analytics. It should not be opaque but on the contrary easily traced by all participants, and it seems important for citizen science projects. We do not use a benchmarking tool arranging scores from a supposedly sophisticated model that is in fact encapsulating a lot of ideological *a priori* without letting the members of projects control their production and relevance. Here, the scales that we used must be very well grounded on the traces we collect.



Sources: [Radar Chart Implementation]

[D3.js - Radar Chart or Spider Chart - Adjusted from radar-chart-d3]

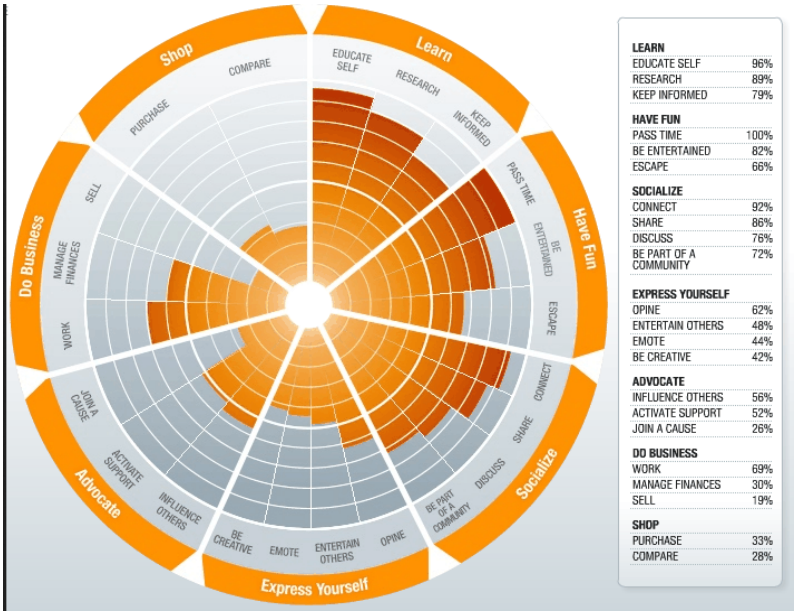
The option without scale....



Source: [Demo Radar chart D3]

Radar chart in percentage

The radar represented through features in percentage is the most suitable design option so far for the cooperation analytics definition we presented. It enables social actors to visualize the plurality of features and indicators that define the cooperation typology in an easy manner. One should be very careful at not piling up indicators to the point where the radar becomes inaccessible while guaranteeing the quality and robustness of the data collected.



Source : [https://i.pinimg.com/originals/af/f4/b6/aff4b6b740fe12c0ff6a31758e4bb56a.gif]

Slack real case of analytics example

Analytics of Slack user activity is well adapted to cooperation practices that have to be accounted for in VERA as Slack is a main communication tool where multiple actors and a variety of multimedia is shared. Slack analytics represent a clear timeline of interactions within the platform that we can reuse (Figure 1). The Slack analytics representation includes a graphical report of the interactions quantified that is clear and easy to follow. In this example it is also useful to retain the short texts that describe the different data reports (Figure 2).

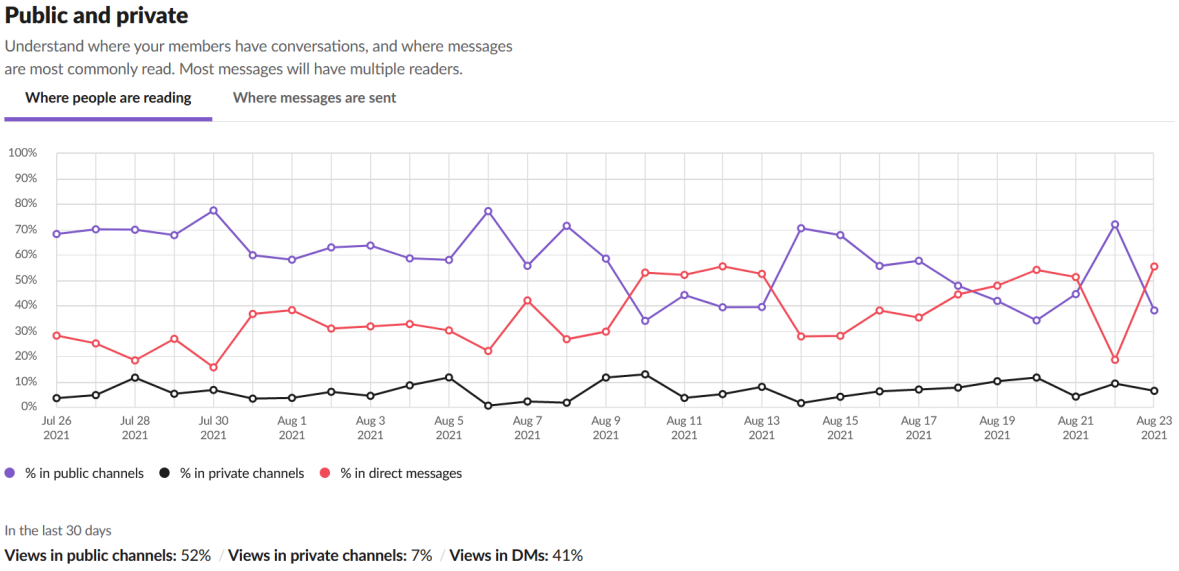


Figure 1: Public and private interactions printscreen of Jessica Pidoux's personal analytics page

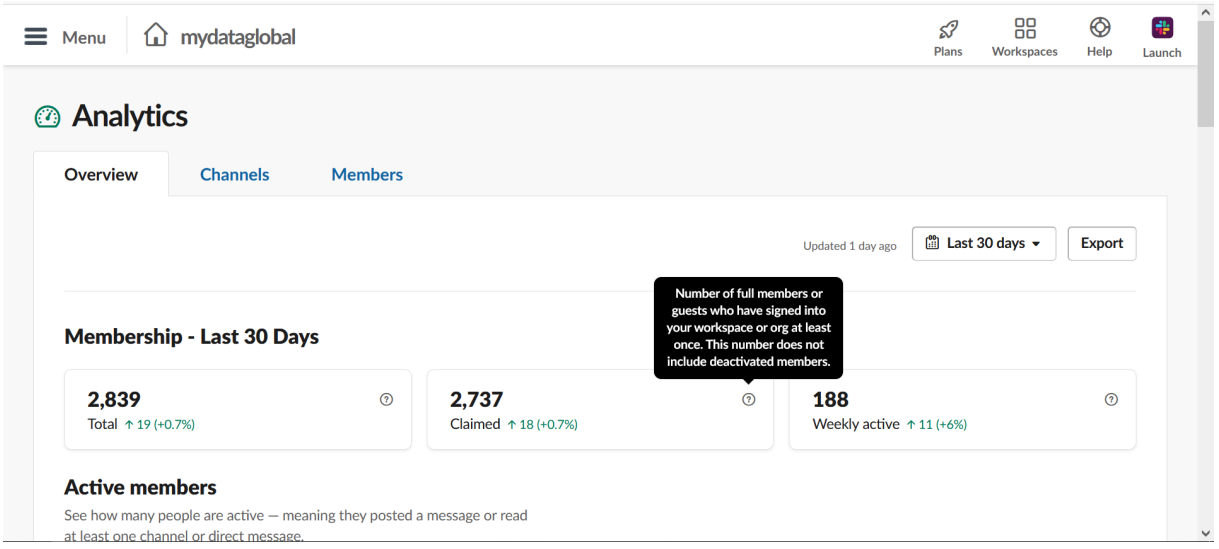


Figure 2: Overview printscreen of Jessica Pidoux's personal analytics page

An alternative approach: the TEFCE Toolbox

The TEFCE project (Farnell, 2021) that measures community engagement in higher education developed "an institutional self-reflection framework for community engagement in higher

education: the 'TEFCE Toolbox'". The author describes it as "mapping the range of community engagement activities that are carried out across the university. It then provides a framework allowing universities to critically reflect on their community engagement. The result is a 'heatmap' indicating areas in which the university performs best, and areas which are in most need of further development. The heatmap is structured according to the seven dimensions of community engagement and to five criteria developed within the project as for community engagement assessment (Farnell, 2021). The dimensions and criteria are not of our interest here but we retain the idea of producing a heat map in different colors as it can avoid presenting too many metrics and scores that lead to competition.

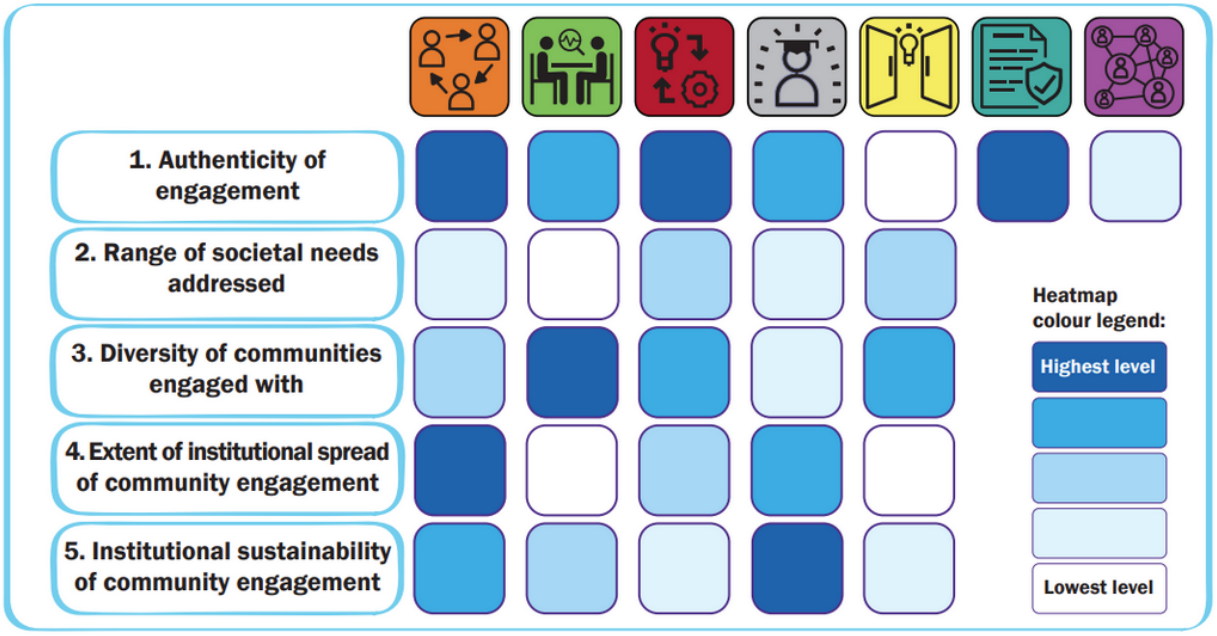


Image 2. Heatmap developed by the TEFCE project.

VI. Pilots: State of Progress

The following section summarizes Pilots' state of progress. The information was collected from different sources: the original plan as stated in the COESO project, the adaptations made in the course of the project development (as declared by actors) and the actual practices of the main actors in each Pilot that were interviewed by ourselves in WP5, or by Net7 from WP3 (Table 5). Net7 shared their interviews with WP5 and we have analysed them.

We focus on presenting the observations that can directly influence the functionalities that are going to be implemented in the VERA platform: profiling, chatting, matching.

Interview No.	Pilot No.	Participants	By
1	Pilot 1	research leader	WP5
2	Pilot 1	civil society leader	WP5
3	Pilot 2	The whole team: researchers and non-researchers	WP5
4	Pilot 3	civil society manager	WP5
5	Pilot 4	researcher	Net7
6	Pilot 4	researcher	Net7
7	Pilot 4	researcher	Net7
8	Pilot 5	researcher	Net7

Table 5. Exploratory Interviews conducted/analysed with Pilots

Preliminary Analysis of Pilots

The first observation of the Pilots state of progress is the variety of the number of objectives set. Pilots 1 and 3 have a restricted number of objectives. On the contrary, Pilots 2, 4 and 5 have a large number of objectives to achieve which makes the process more complex to assess than the other Pilots.

The second observation relates to the quantity and type of stakeholders involved in each project. While Pilot 1 is formed by social actors in the same locality, Pilot 5 is formed by a large quantity and different types of stakeholders: each stakeholder with different qualities to measure. Importantly, at this stage it is clear enough to know what can be assessed for the scientific part of the project but it is difficult to define what can be assessed for the citizen part of the project. In part because citizens are not interviewed yet. Research and citizen objectives are not always clearly defined in a common way, they can be operationally distinctive (i.e. Pilot 5) or more

challenging like in the case of Pilot 2 where the dancer and the philosopher are exchanging roles.

The third observation, more critically, is that the research process pipeline is not defined yet in some cases (i.e. Pilots 1, 2). Moreover, the actual phase of the project varies from one Pilot to another one. This plurality is however an opportunity to design cooperation analytics that are capable of assessing projects throughout the whole chain of progress: from its initial work coordination to the dissemination of results.

The fourth observation concerns the variety of working and communication tools. Concerning the working tools, some Pilots that include more data science and engineering work (Pilots 4 and 5) involve a high number of tools and databases used in parallel. Their operations are not centralized, they are multiplatform. Others have not yet found the best working tools adapted to their projects (Pilots 1 and 2). This observation constitutes another opportunity for VERA to become the reference platform adopted for communicating and working together to some extent according to the operational tasks of each project.

Concerning the communication tools, well-known platforms are recurrent across projects: social networks and Google docs. Slack is not favored by any project as actors have tried it but without giving it much utility. The main channel remains emails, videoconference tools like Zoom for those working mainly remotely (Pilot 1), and telephone calls for those which are already working face-to-face (Pilot 2).

Finally, Pilots present different cooperation challenges that have to be considered in order to be able to offer well established measures of cooperation. This way, the cooperation analytics are limited within a scope of what can, and cannot, be measured given the clarity of the activities of each project. It is important to note that Pilots 4 and 5 have a clearer view on what they expect from VERA, other Pilots have no expectations and remain receptive to what can help them better cooperate.

Challenge

One of the main challenges for defining cooperation analytics is the lack of conventions within Pilots that guide their cooperation practices. For instance, the communication means used, dissemination formats and common language, that are taking place in different environments offline and online across platforms (e.g. Slack, emails, telephone, Google docs).

In addition, Pilots are in a variety of states of progress: from proof of concept to field work, with more or less experience in citizen science and in working together with a pluridisciplinar background in the project (e.g., digital humanities, history and engineering in Pilot 5) and citizen reach (e.g., dancers, general public, non-professional dancers in Pilot 2). The multiple actors involved in each Pilot are therefore currently experiencing the establishment of conventions as a citizen science team, a field that is still building its own epistemology and methodological conventions as seen in the state of the art.

Contribution

WP5 contributes to the establishment of quantifiable conventions that will enable Pilots to review their cooperation on-going practices. The definition of cooperation analytics is based on a

conceptual justification and, equally important, on the situated experience of Pilots that we started observing online given the current health protection measures. Indeed, three out of five Pilots coordinate and operate many activities online (i.e., Pilots 1, 4, 5).

The cooperation analytics we propose are quantifiable conventions that, following Alain Desrosières (2014), enable putting into numeric values, qualities for statistical equivalency, i.e., characterising in an homogenous way as to enable comparability. However, as the author makes us aware, actors rely on statistical indicators to measure a certain performance. Consequently, these conventions organize a social order while it produces a new one, as actors act upon it (Desrosières, 2014). It is a “measured and measuring measure” as Bruno Latour would say.

Therefore, the cooperation analytics we define based on the literature review will be examined along with Pilots. Pilots’ reviewing process of their cooperation practices will ultimately guide us to update the cooperation analytics for the next five Pilots. While the cooperation analytics will serve specific projects within COESO to assess their cooperation practices, the level of generality and comparison across projects that we consider allows the cooperation analytics to become an assessment tool for new projects in citizen science. Our design of cooperation analytics contributes moreover to define and review the standards of citizen science driven by social sciences and the humanities.

VII. Conclusion: Next Steps

Deliverable D5.1 presented first an interdisciplinary state of the art that contributes with the integration of the concept of cooperation into the citizen science field and the identification of specific criteria that define a diversity of cooperation practices.

Second, deliverable D5.1 provided the operationalisation of the cooperation analytics in the form of a monitoring grid that further develops the conceptual framework into analytics that can be adapted to the Pilot realities. In that way, deliverable D5.1 also contributes to formalise and justify a cooperation assessment process that translates the concepts identified in the literature to their actual computable quantification in VERA. The computable translation consisted in presenting the features of cooperation, the construction of indicators, the data collection process and methods for data analysis. This translation presented in the monitoring grid is what finally makes operational the conceptual framework.

In addition, we presented our preliminary analysis of the pilots' practices based on interviews by focusing on the elements that represent a challenge for WP5 and our contribution to Pilots and more broadly, to other citizen science projects. We conclude this deliverable by presenting the WP5's next two steps for implementing the cooperation analytics into VERA.

Cooperation analytics review with Pilots

The next step of WP5 is to review the cooperation analytics with Pilots. The social actors are the main evaluators of the adaptability of these indicators to their realities. For this reviewing process, we are currently analysing the best options for creating a co-design process with Pilots so the cooperation analytics are not given in a top-down manner. Instead, we intend to provide the monitoring grid as a resource for discussion and receiving the practitioners' feedback. The grid will be given as a support to negotiate and update the criteria, as well as to test its comprehension according to the practitioners' practices. The results of reviewing work with Pilots will allow us to reduce the number of criteria to be measured according to what makes sense to them and their daily practices.

Cooperation analytics implementation

As it is shown in this deliverable, we defined a cooperation analytics monitoring grid that contains a large number of indicators and that is mainly conceptual. The extensive list enables us to see the possibility of measuring cooperation according to the literature and the first exploratory observations made about the Pilots. However, this possibility of measurement is limited to the criteria that can be actually collected within VERA given its functionalities yet in development, including the API connections, e.g. for funding, and the decision that will be taken according to the user research outputs and consequent platform design. Consequently, the cooperation analytics will be adapted and limited according to the infrastructure capability of VERA as designed in WP3 (which is currently in the UX research phase).

For this final adaptation step of our monitoring grid, discussions will be scheduled with the COESO partner Net7 to have a clear and detailed view on the platform's functionalities

development once the platform design will be in a more mature stage. After these steps, WP5 will deliver recommendations to Net7 in the form of a technical report in December 2021 presenting the cooperation analytics and its concrete implementation. These recommendations have to be discussed and delimited with the WP3 envisioned work plan for the platform development.

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