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The Ladder of Power: Science Communication and Citizen Science

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Abstract

On March 28, 2022, the *Journal of Science Communication* published a special issue on participatory science communication featuring 15 papers and essays. The *Journal of Science Communication* special issue sparked a debate among the four editors over the wording of the call for papers. What is the difference between "participatory science communication" and "citizen science"? Are they different points along a continuum stretching from "simple" to "more involved"? Does "citizen science" incorporate "participatory science communication"? And is all citizen science participatory? A key consideration is the level of involvement by "citizens" in these endeavours, and that consideration translates to questions of power. This essay explores definitions of participatory science communication and citizen science. It examines each of these concepts through the framework of shifting relationships and the implicit power imbalance between scientists and various publics. In doing this, we revisited Sherry Arnstein's (1969) paper, "A Ladder of Citizen Participation", and constructed complementary ladders for science communication and citizen science.

Keywords

participatory science communication, citizen science, ladder of participation

A Escada do Poder: Comunicação de Ciência e Ciência Cidadã

Resumo

A 28 de março de 2022, a *Journal of Science Communication* publicou um número especial sobre comunicação participativa de ciência com 15 artigos e ensaios. A edição especial da *Journal of Science Communication* suscitou um debate entre os quatro editores sobre a formulação da chamada de trabalhos. Qual é a diferença entre "comunicação participativa de ciência" e "ciência cidadã"? Serão pontos distintos ao longo de um continuum entre "simples" e "mais envolvidos"? Será que a "ciência cidadã" engloba a "comunicação participativa de ciência"? E será que toda a "ciência cidadã" é participativa? Uma das principais considerações será o nível

de envolvimento dos "cidadãos" nestes esforços e que tal consideração se traduz em questões de poder. Este ensaio explora as definições de comunicação participativa de ciência e ciência cidadã. Examina cada um destes conceitos através do quadro das relações de mudança e do desequilíbrio de poder implícito entre cientistas e vários públicos. Ao fazê-lo, revisitamos o trabalho de Sherry Arnstein (1969), "Ladder of Citizen Participation" (Escada de Participação Cidadã), e construímos escadas complementares para a comunicação da ciência e da ciência cidadã.

Palavras-chave

comunicação participativa de ciência, ciência cidadã, escada de participação

1. Introduction

On March 28, 2022, the *Journal of Science Communication* (JCOM) published a special issue on participatory science communication (Metcalfe et al., 2022). It featured 15 papers and essays, all extensions and additions to discussion sessions at the "2020+1 Conference" of the Network for the Public Communication of Science and Technology.

The JCOM special issue sparked a debate among the four editors over the wording of the call for papers. Our difficulty lay in establishing the distinction between "participatory science communication" and "citizen science". Are they different points along a continuum stretching from "simple" to "more involved"? Does "citizen science" incorporate "participatory science communication"? And is all citizen science participatory?

We suggest that a key consideration is the level of involvement by "citizens" in these endeavours and that consideration translates to questions of power. Who instigates the research? Who designs the experiments? Who conducts the analysis and determines the way the results will be disseminated? Full participatory science communication has publics playing at least an equal role in all phases. As Anne Leitch (2022) said in her article in the special issue: "power includes who decides who is invited (or not invited or actively excluded) to participate and how that process unfolds. It also includes notions of what is counted as expertise, and thus included or omitted in the process" (p. 2).

This essay explores definitions of participatory science communication and citizen science, examining each of them through the framework of shifting relationships and the implicit power imbalance between scientists and various publics.

2. Arnstein's "Ladder of Participation" Shows Progressive Increase in Power

One approach to assess levels of participation and power, whether in science communication or citizen science, was set out by Sherry Arnstein (1969) in her much-cited "A Ladder of Citizen Participation" paper of 1969. In an analysis described as "penetrating, no-nonsense, even pugnacious" (Organizing Engagement, n.d., para. 2), she examined urban renewal and anti-poverty programs in the United Sates, where the communities she studied were invited to participate in new programs to improve their neighbourhoods.

Arnstein's (1969) eight-level "ladder of participation" (see Figure 1) illustrates her observations. The two lowest levels are labelled "manipulation" and "therapy", and subsequent rungs employ similar value-laden terminology.

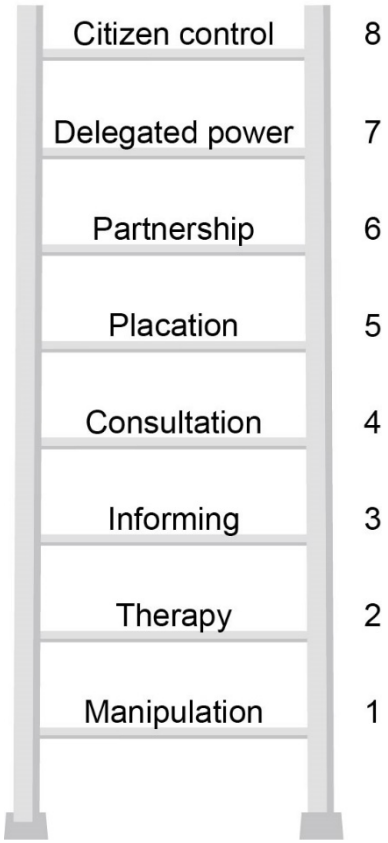

Figure 1 *Arnstein's ladder of participation*

Source. Adapted from Arnstein, 1969, p. 217

Arnstein (1969) works on the principle that participation equating to higher rungs on her ladder is more worthy because of their power-sharing potential. In describing the lower rungs of the ladder, she explains:

> these two [bottom] rungs describe levels of "non-participation" that have been contrived by some to substitute for genuine participation. Their real objective is not to enable people to participate in planning or conducting programs, but to enable powerholders to "educate" or "cure" the participants. (p. 217)

Arnstein (1969) claimed the lower rungs of participation gave officials the licence to placate, to muzzle or to "educate" disadvantaged groups. To her, the urban renewal programs were often "chicanery" and "a sham" (Arnstein, 1969, p. 218). But as citizens participated more fully and more meaningfully and moved to the higher rungs, they had greater powers: to negotiate, to partner and eventually, on the top rung, to have full control.

For a project to be genuinely participatory, Arnstein (1969) felt a program had to include a redistribution of power.

> Citizen participation is citizen power. Without an authentic reallocation of power—in the form of money or decision-making authority, for example—participation merely "allows the powerholders to claim that all sides were considered but makes it possible for only some of those sides to benefit. It maintains the status quo". (Arnstein, 1969, p. 216)

While the simplicity of Arnstein's (1969) ladder is attractive, it masks some limitations. Arnstein believed that higher levels of participation are always better than lower levels when she considered her (familiar) field of urban renewal projects. But in other projects and in other disciplines, participation at lower levels may have significant value, and participating at the higher rungs may be unrealistic. For instance, citizens may be perfectly capable of counting birds accurately or learning the skills needed to collect and analyse data reliably but may benefit from researchers developing identification apps or publicly searchable databases that can be interrogated based on citizens' needs.

There is a parallel in science communication, where some scholars see participatory science communication as a desired evolutionary endpoint that replaces deficit and dialogue-style science communication (Metcalfe, 2019). But, just as linear science communication can have value and even be demanded by various publics (for example, to satisfy their need for information), it is also likely that lower levels of participation in urban renewal projects have value.

3. Postulating a Ladder of "Participatory Science Communication"

In our call for papers for the JCOM special issue, we chose to define participatory science communication in terms of recognising citizen equality:

> participatory forms of science communication appear to be different to popularisation, science literacy and dialogue in that they recognise and acknowledge various publics as being equal in terms of the power and knowledge they hold when compared with scientists and policy makers. (Metcalfe et al., 2022, p. 4)

However, some authors in the JCOM series thought it better to avoid an explicit definition. Anne Leitch (2022) advised avoiding "prescriptive definitions, recognising that the rationale and process of participation are context-specific and should be tailored and revised throughout" (p. 5). That does illustrate some of the definitional challenges associated with participatory science communication.

The fluid nature of participatory science communication was also recognised by Chi-I Lin (2022), who discussed the "constant dialogue, exchange of knowledge and

negotiation" that happens between farmers and scientists in her study (p. 3). Lin perceives linear forms of science communication (dialogue, exchange of information) as part of the spectrum of participation.

In exploring the nature of participatory science communication, other authors in the JCOM special issue recognise how power dynamics change compared with linear forms of science communication. Standerfer et al. (2022) describe participatory science communication as "a discursive space that recognises and values participants' lived experiences and community knowledge" (p. 2). Their description is echoed by Rita Campos (2022), who talks about "giving the same weight to both scientific and local or indigenous knowledge" (p. 4). The point "the same weight" is crucial because it highlights power sharing.

Ayure and Triana (2022) emphasise the importance of levelling power relationships with participatory science communication in their Colombian project:

> the differential factor of Ideas for Change is challenging researchers and scientists to work as a team with community organizations to solve local problems, through building a relationship that is based on collective well-being. In this scheme, relationships are based on respect between peers; academic titles do not grant authority but trust. (p. 5)

Another group of JCOM authors looked at how participatory science communication can achieve a level of interaction between scientists and publics that goes beyond valuing participants' knowledge and experience. Thomas and Cassidy (2022) recognise the democratic potential of participatory science communication, describing it as "engaged research", quoting Holliman et al. (2015): "researchers meaningfully interact with various stakeholders over any or all stages of a research process, from issue formulation through the production or co-production of new knowledge, to knowledge evaluation and dissemination" (p. 1).

All these interpretations demonstrate intentions for extending the transmission or exchange of information and ideas to a stage where various publics are deliberatively engaged with scientists and the research process on an equal basis. While much of this participation is still initiated and framed by scientists, science communicators and their institutions, it does indicate a willingness to shift power and agency in projects toward publics.

Considering this work, we provided a revised definition for participatory science communication in the introduction to the JCOM special issue:

> "participatory science communication happens when scientists and/or science communicators interact with various publics in a dynamic process where different forms of knowledge and experiences are acknowledged, shared, valued and negotiated, and where power relations are levelled." We consider that such participatory processes can lead to more inclusive and democratic perspectives of collective knowledge sharing and appropriation. (Metcalfe et al., 2022, p. 5)

We have adapted Arnstein's (1969) ladder to offer a similar ladder of science communication, with the most participatory forms at the top of the ladder (see the middle ladder in Figure 2).

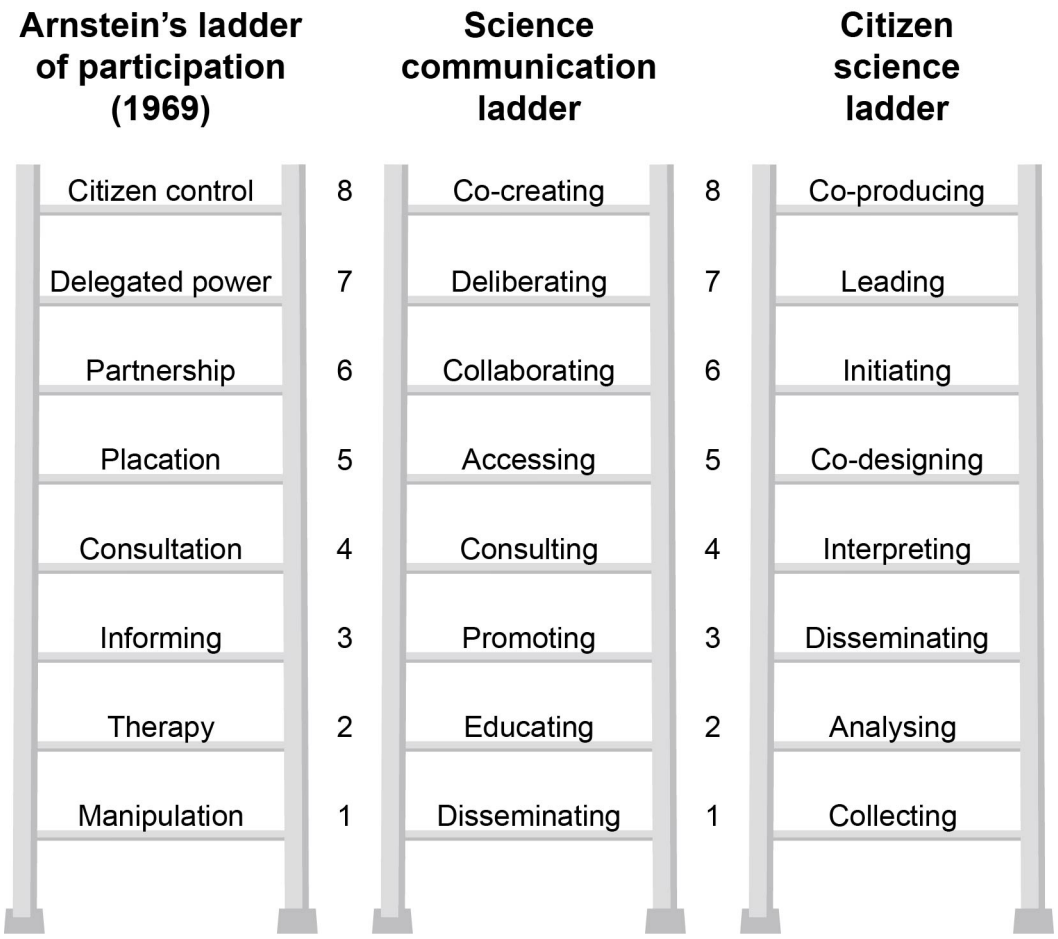

Figure 2 *Arnstein's ladder of participation compared with proposed science communication and citizen science ladders*

The first three rungs on the science communication ladder are dominated by one-way communication from scientists to various publics. "Dissemination" is the straight transfer of information from scientists to publics. While scientists have most of the power here, they may be responding to publics' demand for knowledge rather than a perceived public deficit. The "education" rung of the ladder also implies a transfer of information or knowledge from those with notional expertise (scientists) to those without information or knowledge (publics). However, interactions between scientists and publics through educative processes can move communication beyond mere dissemination. The "promotion" of science can also occur through more interactive or participatory processes.

A more deliberative dialogue between scientists and the publics starts with "consulting" activities. Here scientists acknowledge that publics may have concerns or knowledge which must be considered in the research processes. However, consultation is still

directed largely by scientists and their institutions. "Accessing" provides publics with more direct pathways to scientists, their research and the knowledge produced by that research. By having this access, publics are gaining greater opportunities to influence the scientific process.

The top three rungs of the science communication ladder are far more participatory in nature. "Collaboration" implies that the publics are at least contributing their knowledge and/or skills to scientific processes, including the generation of new knowledge, even if they do not have equal status to scientists. "Deliberating" gives the publics more power as they become actively involved alongside scientists in knowledge generation and problem-solving. The top rung of the ladder, "co-creating", means that the publics are now participating on an equal basis with scientists and may even be initiating research activities.

The science communication ladder does not imply a higher value to the top rung activities. There can be value in communication activities performed at any of these levels (for instance, providing farmers with an analysis of their soils). We recognise the importance and indeed likelihood of a mix of styles in any science communication program (e.g., see Metcalfe's [2022], paper, in JCOM on the Australian Climate Champion Program), including in programs where citizens co-create or lead communication activities.

4. Creating a Ladder of Citizen Science Participation

When we defined participatory science communication in our introduction to the JCOM special journal (Metcalfe et al., 2022), we distinguished between these activities and citizen science:

> participatory science communication differs from the common definition of citizen science projects where citizens collect data separately to any deliberation or analysis by scientists. But citizen science is a broad field, and in its more extended form can involve publics in problem definition, collection and data analysis. (p. 4)

The broad and diverse nature of citizen science has led to a range of definitions of what it is and how it should be enacted. These definitions often vary according to the level of participation and the power those citizens have in a citizen science program.

"Citizen science" came to prominence as a term in about 1995. But the idea is a lot older: for instance, Bonney (1996, as cited in Hecker et al., 2018) describes lighthouse keepers collecting data about bird strikes in 1880. Bonney worked at the Cornell Lab of Ornithology Citizen for 4 decades from the early 1980s. He was director of citizen science and director of public engagement in science programs; and has published widely on citizen science (see Cornell Lab, n.d.).

In 2009, Bonney and colleagues published a nine-step model for the development of a citizen science project, with the steps set out in chronological order (Bonney et al., 2009). That saw a limited role for citizen participants who were recruited for a simple purpose: to

count birds. The possibility that participants might have expertise in bird recognition or knowledge of the local environment that might shape the project was never entertained. Citizens were not involved in the design of the experiment, analysis and interpretation of the data or dissemination of the results.

Such definitions were typical of the citizen science movement in the United States, which largely involved large-scale data collection by citizens. We would argue that this style of citizen science is unlikely to be participatory science communication. The role of citizens in gathering data is important and useful, but the power still resides with the scientists, and their communication with citizens is likely to be linear in nature: providing information and responding to any questions they might have.

This perception of citizen science contrasted with European notions of citizen science in the early part of the 21st century, which looked at the engagement of the public in scientific discourse and policy making. For example, Irwin (1995) conceives of citizen science as a form of citizen engagement, which translates into political activity designed to facilitate high-risk decision and policy making. This style of citizen science would suggest a much more participatory form of science communication, with citizens involved at all stages right up to the co-production of policy.

Between 2013 and 2015, European groups worked on bringing a better understanding of the field with their "Ten Principles of Citizen Science" (Robinson et al., 2018). These principles recognise the different roles (and hence power) that citizens can play in citizen science projects. The history and wording of the principles were explored and dissected by Lucy Robinson et al. (2018), who describe how the principles were developed. "Citizens may act as contributors, collaborators, or as project leader and have a meaningful role in the project... [which] may include developing the research question, designing the method, gathering and analysing data, and communicating the results" (Robinson et al., 2018, p. 29).

Friedman and Rosen (2021) go beyond the 10 principles to set out a case for co-production in citizen science in their extraordinary story of Israeli citizens winning a battle against the development of oil shale fields. The secretive plans by powerful interests in Israel were discovered by a pair of mountain bikers in the Elah Valley. The pair drew together eight local residents who met, allocated tasks (setting up a website, raising funds, contacting politicians) and waged a battle the authors labelled "David versus Goliath". Their victory was a result of the determination, hard work and the bringing together of a group of people with disparate skills:

> Co-production also has a more prescriptive understanding and refers to the activity of co-producing knowledge for a project or policy. As a prescriptive agenda, the goal of co-production is to generate policy via the input of as many stakeholders as possible from various levels of governance and the citizenry, thereby creating a means whereby social and scientific knowledge and processes continually inform one another. (Friedman & Rosen, 2021, p. 4)

This type of activity is similar to what many scholars theorise as high-level participatory science communication. In this type of citizen science, the public shares power with scientists.

It appears that citizen science, like science communication and urban citizen participation, can be captured and described in a hierarchical ladder that demonstrates different levels of participation and, therefore, citizen power. This notion of a hierarchy is also found in one of the special-issue JCOM papers, which looked at citizen science in solar energy research (Barbosa et al., 2022). The authors define citizen science within the context of participatory science communication by saying it "can be categorized into three practices: contributory, collaborative or co-created" (Barbosa et al., 2022, p. 2). They saw co-created citizen science as the most participatory.

We used these definitions and explanations of citizen science to construct a citizen science ladder (Figure 2). The first three rungs on this ladder (collecting, analysing and disseminating) match what Barbosa et al. (2022) call "contributory". With "collecting" and "analysing", citizen scientists are performing relatively simple tasks that aid scientists in their research activities. When citizen scientists get involved in "disseminating", they are helping scientists transfer the information that has been generated from the citizen science activity. That differs from "disseminating" in the science communication ladder, where scientists perform the communication.

The next three rungs (interpreting, co-designing and initiating) reflect "collaborative" activities between citizens and scientists. When citizens get involved with "interpreting" and "co-designing", they are exercising more power in the scientific process than when engaged in the previous rungs of the ladder. Scientists are now valuing the ability of citizens to interpret data and design research activities.

The top two rungs (leading and co-producing) will likely lead to scientists and citizens "co-creating" new knowledge or policy. That is where there is likely to be a much greater sharing of power, and citizens will have a hand in driving the project. "Co-producing" is more participatory than "leading" as citizens are more likely to be working alongside scientists rather than driving what scientists do.

This citizen science ladder is hierarchical rather than sequential; each activity captured in the ladder does not depend on the completion of previous activity steps to occur. For example, citizens can be engaged in co-designing a project without ever being involved in collecting data. Like our proposed science communication ladder, progression up the ladder rather shows increasing citizen participation in the scientific process which comes with a shift of power from scientists to the publics. While citizens are likely to have more power when "leading" compared to "co-producing", we have placed co-producing at the top of the ladder because this is when citizens are likely to be participating with scientists on an equal basis.

Like the science communication ladder, the citizen science ladder differs from Arnstein's (1969) ladder because it sees a potentially important role for all the steps in the ladder, from collecting data upwards.

5. Conclusion

We opened this article with questions revolving around the distinction between "participatory science communication" and "citizen science" and the role of non-scientists in these projects. After examining many discussions and definitions, we conclude that citizen science activities can align on a continuum based on the power that citizens hold within a citizen science project and that this continuum parallels the power sharing ladder along which participatory science communication activities can be categorised.

When a citizen science project involves citizens leading a project and/or co-producing outcomes from a project, then the project likely involves the highest levels of participatory science communication. Citizens working with scientists to interpret results, co-design projects and/or initiate projects are also likely to be involved in participatory forms of science communication. Citizen science projects that only involve citizens in collecting, analysing and disseminating are likely to be dominated by more linear forms of science communication. Citizens are participating in the science through contributory efforts but are unlikely to be involved in participatory communication with scientists.

However, unlike Arnstein's (1969) "A Ladder of Citizen Participation", where she uses value-laden terminology to make a critique of participation on the lower rungs, we would emphasise that all levels in science communication and citizen science ladders have value. Moreover, it is likely that the higher rungs in the ladders depend on the activities of the lower rungs.

Understandings of "good" science communication are changing. Participatory approaches recognise the value of what citizens bring to science communication, and this is imbuing the field with new approaches. Despite the attractiveness of these approaches for the science communication field, adopting these approaches has not come easily for many researchers and institutions because it requires recognising the limitations of formalised scientific knowledge and the value of the knowledge of people who may not have had the same educational experiences. It calls for a shift in power and a new humility for professional scientists and the institutions that support them. The emergence of responsible research and innovation is bringing new momentum to shift "science in society" to "science with and for society".

Melanie Smallman et al. (2020) argue that responsible research and innovation has significant implications for science communicators involved in public participation:

> the concept has arguably shifted the role of the science communicator from one who explains science to the public to one who helps scientists and technology developers understand society. Arguably the objective of helping science to succeed remains, but it is achieved by helping science do more socially acceptable research. (p. 947)

In tandem with the notion of "participation" that is spreading through both science communication and citizen science, there is growing recognition by researchers

and practitioners for creating space for different types of communication. For some situations, the dissemination of expert advice is appropriate. Other situations call for dialogue between researchers, science communication practitioners and various citizen groups, so the knowledge and views of all can be heard, debated and resolved. The third approach is participatory, where researchers work on equal footing with citizens and citizen groups to start a project, frame the research questions and approaches to collecting and interpreting data, and collectively engaging others with the results.

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