

Towards effective knowledge co-production and deliberation: developing public engagement competencies among scientists and policymakers

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Abstract

Governments committed to the Paris Agreement are obligated to empower the public to participate in decision-making on climate change. Research shows that higher levels of public engagement (PE) lead to fairer, more inclusive, and socially acceptable policies and outcomes. Yet significant gaps remain between obligation and implementation due to institutional, structural and social-psychological factors faced by policymakers and scientists. This study developed a situated, longitudinal training programme to support decision makers new to PE overcome these challenges. Incorporating learning-by-doing, critical reflection, and social support the programme enabled 19 of 20 participants to gain new knowledge, understanding, and skills related to knowledge co-production and deliberation. Additionally, 30% demonstrated positive changes in PE attitudes and values, and 40% noted behavioural shifts favourable of PE. Competency development was influenced by factors such as programme enjoyment, opportunities for reflection, and perceived suitability for PE roles. Just as policies require public acceptance, public participation requires decision-makers acceptance. To further the social acceptance of knowledge co-production and deliberation, increased funding and integration of comprehensive, experiential PE training in institutions and programmes. Pre- and post-programme evaluation is also needed to assess learning, barriers, and pathways to ethical knowledge co-production and deliberation.

Keywords Sustainability · Public engagement · Co-production

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1 Introduction

To address interconnected global challenges like climate change there is growing demand for public engagement (PE) in decision-making processes across research, policy, business and public service sectors (Bason & Austin, 2022; Loeffler, 2021; Murunga et al., 2024; Pieczka, 2018; Tuurnas, 2020). This paper defines PE as a relational approach to decisionmaking that includes diverse publics in varying degrees of learning, action and reflection, depending on the goals of the initiating parties (IAP2, n.d.; Centre for Public Impact, 2021; Wibeck, 2014). PE spans from informative, inspirational and consultive to empowering, deliberative and co-produced methods, where publics participate in multiple or all stages of the decision-making (governance) process (IAP2, n.d.; Hügel & Davies, 2020; Fig. 1). Coproduction is the most systematic method, intended to facilitate power sharing in contextspecific governance design and processes (Norström et al., 2020). Through co-production diverse publics including indigenous and place-based communities are invited to co-produce the research issues and data collection and participate in policy discussions to debate which are the most appropriate in their context (Fig. 1). This democratic model emphasises inclusive participation throughout the process, rather than limiting involvement to the final stages of research/policy development as in the "knowledge deficit" model (Sturgis & Allum, 2004). Examples include participatory citizen science, citizen juries, participatory budgeting, citizens assemblies, co-governance models with indigenous communities and Nature/Youth in the boardroom (Faith in Nature, n.d.; Good Energy, n.d.; Orr & Powell, 2023; Mattei, 2023; Alexander, 2022; Muradova et al., 2020; Fung, 2015).

Research demonstrates that higher levels of participation lead to fairer, more inclusive and socially acceptable processes, policies and outcomes (Romsdhal, 2020; Jami & Walsh, 2017; Sherman & Ford, 2014). This is because such dialogic and co-produced approaches tend to the complexity and value-laden nature of interconnected global challenges, aiming to incorporate diverse social-ecological ways of knowing, doing and relating, and the lived experiences, needs and priorities of those most impacted by development (Abram et al., 2022). These approaches also support behavioural change, trust building, a shared



Fig. 1 Participation choice points in research and policy cycles. Adapted from Vaughn & Jacquez, 2020 and emm2.0 n.d.

identity and issue reframing (Besley et al., 2015; Khatibi et al., 2021; Muradova et al., 2020; Murunga et al., 2024; Nisbet, 2010; O'Brien & Sygna, 2013).

Despite this evidence and international obligations for integrating such approaches through Article 7, 11 and 12 of the Paris Agreement (United Nations Framework Convention on Climate Change (UNFCCC), 2015) informative and consultative models dominate across sectors (Bason & Austin, 2022; Khatibi et al., 2021; Stylinski et al., 2018; Ward et al., 2022). Empowering approaches remain fragmented, undervalued and underfunded due to challenges in resourcing and structures, and the related underlying psycho-social dimensions of leadership and priority setting, perceptions of PE, fears of losing power over decisions, and a limited capacity and willingness to discuss the topic or change existing processes (Murunga et al., 2021; Khatibi et al., 2021; Llorente et al., 2019; Hamlyn et al., 2015; Fung, 2015). Given their interdependent nature, all these challenges must be addressed to ensure processes do not reinforce hegemonies and old ways of working, such as has been demonstrated in international arenas where the voice of the uninvited public is silenced or at best invited participants are offered tokenistic roles (Belfer et al., 2019; Cornips et al., 2023; Pieczka, 2018).

To address these challenges, social engaged researchers and practitioners are being called upon to offer alternative frames to governance, build the capacities of decision makers and offer recommendations on how to address the social dimensions of change (Murunga, 2022; Loeffler, 2021; Romsdhal, 2020; Hügel & Davies, 2020; Blue, 2016). Whilst most studies explore the outside-in processes that facilitate public participation (Khatibi et al., 2021; Centre for Public Impact, 2021), this study examines inside-out factors. Specifically, it explores the PE attitudes of traditional decision makers: scientists, consultants, technology enterprises and policymakers, and how their PE competence changes over time through involvement in co-production processes.

2 Literature review

Before exploring decision-maker competencies it is important to understand their baseline attitudes towards empowering PE and the theoretical underpinning of attitude.

2.1 Specialists' attitudes towards the public's role in decision making

Attitudes consist of normative beliefs expressed verbally and through action tendencies towards specific persons, ideas, objects or groups (Baron & Byrne, 1984). They include affective, cognitive and behavioural dimensions (Jain, 2014). Whether an individual's attitude towards something is positive, negative or neutral, and whether they act accordingly, depends on several mediating factors. These include knowledge, socio-demographics, values, social norms, framing, risk perception, personal and group-level skills (efficacy), perceived benefits, moral duty, enjoyment, opportunity context and mindset (Besley, 2015; Besley & Nisbet, 2013; Besley et al., 2018; Cerrato et al., 2018; Fogg-Rogers et al., 2024; Hendriks & Bromme, 2022; Rissanen et al., 2024; Tam et al., 2021).

Positive attitudes and efficacy beliefs are consistent drivers of PE behaviour among decision makers (Besley et al., 2018, 2019; Copple et al., 2020). However, unlike other areas, where social norms significantly predict behaviour (e.g., Borg et al., 2020; Willis et al., 2020) their influence on PE behaviour is weaker (Besley et al., 2018). This may be

because those with weaker convictions often evolve through repeated, small actions over time, driven by self-persuasion and self-justification rather than social influence (De Meyer et al., 2021).

Survey data suggests scientists tend to view policymakers as the most important group to engage with and do not see themselves as enablers of public participation; nor do they see the benefit of PE (Besley & Nisbet, 2013). Many also doubt the public's ability and willingness to contribute to decision making and perceive a deficit in their scientific knowledge (Besley, 2015; Besley & Nisbet, 2013; Llorente et al., 2019). Furthermore, public trust in the legitimacy of scientific knowledge can vary (Evans & Hargittai, 2020) whilst policymakers sometimes resist increasing public participation (Shaw et al., 2018). Despite their importance in transdisciplinarity, the attitudes of consultants and entrepreneurs are underexplored.

Training is recognized as vital for shifting attitudes by increasing comfort, confidence, and commitment to PE while equipping them with tools to translate rhetoric into practice (Copple et al., 2020; Stylinski et al., 2018; Besley et al., 2018; Tuurnas, 2020). Yet, most training focuses on one-way communication methods, such as social media skills (Copple et al., 2020; Rainie et al., 2015; Yuan et al., 2017, 2019) and overlooks the influence of identities, learning styles and preferences to participation for both decision makers and the public (Baram-Tsabari & Lewenstein, 2017; Besley et al., 2015).

A tailored approach to training is important as the needs and usefulness of PE vary across disciplines (Burri, 2018). Effective training requires tailored, scaffolded approaches and follow-up support, including institutional and disciplinary incentives to sustain behavioural change (Jefferson & Anderson, 2021; Rodríguez-Aboytes & Barth, 2020; Anderson, 2017; NASEM, 2016). Reflective practice — critical for broadening perspectives and transforming interactions (Akkerman & Bakker, 2011; Akkerman & Bruining, 2016; Mezirow, 2018) — is another essential component yet is seldom incorporated into PE activities (Hendriks & Bromme, 2022).

Building on this understanding, this study developed bespoke, longitudinal training for environmental decision makers using scaffolded learning, peer and mentor support, and critical reflection to support them along their PE journey. This framework aimed to foster competencies – skills, knowledge, attitudes, values and behaviours needed for decision makers to be "authorised to judge" (Wong, 2020, p96) empowering approaches to PE.

3 Case studies

The training was applied in two European transdisciplinary research projects aimed at centring diverse publics in science and policy decision making.

ClairCity (**Citizen-Led AIR pollution reduction in cities**) was a four-year EU Horizon 2020 project (2016–2020) focused on quantifying air pollution and climate change policies in European cities, raising awareness about citizens'role in pollution, involving residents in co-developing local policy solutions, and modelling policy impacts for city decision-makers. Partner cities/regions were Amsterdam (The Netherlands), Bristol (UK), Ljubljana (Slovenia), Sosnowiec (Poland), Aveiro (Portugal), and Liguria (Italy). Each location brought together environmental modellers and scientists with policymakers from the city authority as well as consultants and technical specialists, all tasked with engaging the public. The project engaged 8,302 citizens directly and reached over 100,000 via social media. Engagement activities included a serious game app, neighbourhood workshops, and school competitions, which contributed to strategic innovations in city policies (ClairCity, 2021).

WeCount: Citizens Observing Urban Transport was a 2-year EU Horizon 2020 transdisciplinary environmental research project (2019–2021) enabling citizens with low-cost traffic sensors to quantify local road transport, generate scientific data, co-design solutions for their local challenges, and advocate for change. Case studies were conducted in Madrid and Barcelona (Spain), Leuven (Belgium), Ljubljana (Slovenia), Dublin (Ireland) and Cardiff (UK). Each location had a PE partner, with support from centralised air quality, social science and sensor expertise. WeCount engaged 843 citizens and external partners through events and workshops, with 368 citizens actively counting. Unlike ClairCity, WeCount emphasized ongoing public participation throughout the research cycle, including co-creating data platforms, research questions, and advocacy elements. Due to the COVID-19 pandemic, recruitment and engagement took place online/outdoor spaces when permitted. Full PE methods for both projects are detailed in Fogg-Rogers et al., 2021 and Sardo et al., 2022.

4 Materials and methods

4.1 Training programme

The training programme comprised four key elements:

- **Initial workshop**: conducted during project initiation, it introduced PE theory and better practice while allowing decision makers to experiment with practical skills such as audience segmentation, communication, and evaluation.
- Learning-by-doing: decision makers engaged their publics through staggered activities at some/most stages of the research/policy cycle, enabling iterative learning.
- **Guidance documents**: tailored resources supported specific activities, such as on how to assess audiences' level of participation or how to disseminate findings.
- **Support and learning**: learning and reflection was facilitated through team meetings and partners involvement in the evaluation, and through mentoring and open and proactive communication with the training team.

ClairCity members received the full training (excluding mentorship) with partners required to apply specific PE methods to specific audiences. Building on these insights, WeCount included mentorship and allowed greater flexibility in and adaptation of engagement approaches. As the team were more experienced in PE, the initial workshop was optional.

4.2 Evaluation

The training programme and its impact were evaluated through semi-structured interviews with participating decision makers. A series of semi-structured open-ended questions were devised to capture this data, allowing for in-depth discussions on practitioners' learning over time (Rosenthal, 2016). Questions explored broad topics (e.g., challenges and successes), framework-specific aspects and competency development. All were invited to participate in interviews near the end of the projects, via video call or email.

4.3 Analysis

Interviews were transcribed by a GDPR-compliant service with personal details, names and locations (where appropriate) anonymised. Reflexive thematic analysis was then performed using NVivo 1.6.2 to explore patterns across the data (Braun & Clarke, 2019). The process involved data familiarisation, line-by-line coding, and thematicization using a mix of inductive and deductive reasoning followed by quote condensation and writeup (ibid). Content analysis was then conducted by professional background and other a priori factors to understand how learnings differed among groups (Krippendorff, 2004). Analysis was performed by the lead author and reviewed by the co-authors. Throughout the process, authors were mindful of their influence on both interviewing and analysis (Braun & Clarke, 2019; Madill et al., 2000).

5 Results

5.1 Participant characteristics

26 project partners participated in the interviews from a combined consortium of 83 members. 16 were from ClairCity (31% of 52) and 10 from WeCount (32% of 31), encompassing all professional backgrounds involved. Among these, 15 (94%) from ClairCity and six (60%) from WeCount had little to no PE experience (Table 1). Results primarily focus on the 20 actors with no/limited experience. When the accounts of PE experts are included, this is made explicit.

5.2 Themes

Two primary learning domains were identified among the 20 actors and eight themes of shared meaning were identified. These themes, along with the number of respondents mentioning them, are summarised in Table 2 and elaborated upon in subsequent sections.

5.2.1 Enabling conditions for learning

Four interrelated aspects were central to participants learning.

Acknowledgement of emotions Despite initial training, 30% (N=6) of participants, N=4 from ClairCity, expressed fears and concerns about engaging the public – be they citizens, policymakers or teachers. Specific challenges included reaching those most impacted by but least responsible for environmental issues. Participants also cited barriers such as insufficient time or feeling unprepared for PE. Additionally, two (10%) expressed concerns about the significant workload involved.

Interview code (discipline)	PE experience	Professional (environmental) background
CC1(C)	Novice	Policy consultant
CC2(S)	Some	Modeller
CC3(P)	Some	Policymaker
CC4(S)	Novice	Modeller
CC5(C)	Novice	Policy consultant
CC6(P)	Novice	Policymaker
CC7(S)	Some	Scientist
CC8(P)	Novice	Policymaker
CC9(S)	Some	Scientist
CC10(P)	Novice	Policymaker
CC11(S)	Novice	Modeller
CC12(S)	Some	Modeller
CC13(P)	Novice	Policymaker
CC14(P)	Some	Policymaker
CC15(PE)	Expert	PE specialist
CC16(P)	Some	Policymaker
WC1(PE)	Expert in PE, novice in evaluation	PE specialist
WC2(PE)	Expert in PE, novice in evaluation	PE specialist
WC3(PE)	Expert	PE specialist
WC4(PE)	Expert	PE specialist
WC5(S)	Expert	Planning academic
WC6(S)	Novice	Architecture academic
WC7(S)	Some	Modeller
WC8(S)	Some	Smart and Sustainable Cities academic
WC9(S)*	Some	Modeller
WC10(T)	Some	Technical specialist (enterprise)

Table 1 Interview participants' PE experience and professional background

S Science; P Policy; PE Public engagement; C Consultant; T Technical

Novice = no experience. Some = has taken part in some form of engagement, namely informative/inspiring activities. Expert = has taken part and feels at least somewhat competent in the full spectrum of engagement activities

*WC9 was interviewed as CC11 in ClairCity so is counted as one person during analysis

"At the beginning, due to a lack of confidence, I was really afraid, I wasn't prepared for this kind of job...we had some short training during an afternoon, but it wasn't long enough to get all the rules, so that was the biggest challenge...It's much easier to work with numbers and computers than with people...." -CC4(S)

Context Participants feelings and preconceptions also related to their broader context, as noted by 18 (90%). This broad category encompassed historical and political (N = 10), global (COVID; N = 9), technological (N = 7), organisational (N = 4), and timing (N = 5)-related factors. For some, these factors were advantageous, such as working in a city that is supportive of and familiar with PE; for others these were barriers, including self-perceptions of being unsuited for this type of work. When perceived negatively, these aspects led to a loss of energy and motivation.

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Table 2 Domains and themes			
Domain	Theme	Illustrative quotes	N
Enabling conditions for learning	Acknowledgement of emotions	At the beginning, due to a lack of confidence, I was really afraid." (CC4)	9
	Context	It is a big city; a lot is happening already. Many people are already very aware" (CC1)	19
	Training programme design	T learnt but I feel that in the end they learnt something from me too" (CC12)	12
	Enjoyment	I did enjoy working with citizens, yes, because of all the feedback you get because you feel like you are really creating an impact on the democracy part." (WC3)	13
Competency development	Character traits	'Yes, you have to be passionate, [but] not false." (WC10)	×
	Knowledge, understanding and skills	T have learned to be less scientificI've learned the value of listening." (CC11)	20
	Attitudes and values	Before, I was thinking about how to go to people and to say what we are doing, but now also, how to go to people and learn from people and to bring it with our classic approaches' (CC4)	∞
	Behaviour or behavioural intention	T think my own perceptions of public engagement have changed massively. I've certainly seen that in the way I talk to people about the issue." (CC11)	14

"My biggest concern was whether it would be possible to establish good cooperation with residents and stakeholders and involve them... There is a significant number of citizens in my country (Slovenia), who are still accustomed to not deciding about anything because the authorities do it for them, like it was in the Communist regime... I was afraid also if it would be possible to engage policymakers successfully in the project." -CC16(S)

"The best results were indirect activities (online surveys). Interviews and proximity contacts are much more difficult to implement due to inexperience, lack of knowhow and sufficient human resources" -CC6(P)

Training programme design 19 (95%) participants mentioned the influence of the training on their experiences. Most stated how the design enabled greater cooperation and mutual learning and reflection between one another, citizens and local organisations (N= 12; 60%).

"The public is interesting, but I think we learn much more with our colleagues... it was very important for me that I had the feeling that my colleagues were waiting for my contribution and respected my contribution and my point of view, so it's a big directional learning process. I learnt but I feel that in the end they learnt something from me too." -CC12(S)

"I think it was helpful to [have an evaluation mentor to help us] understand everything because it was a really complex framework with all the templates and with everything else... In this sense it was very helpful to go through all the evaluation and not be lost in the framework." -WC4(PE)

Lastly, the practical aspects of the training enabled specialists to work more closely with diverse stakeholders. Feedback during this process positively shaped their experience (N = 4).

"When I go out and talk to local authority networks [they say] "wow, this is a big jump forward, this is a big step forward, you're dealing with a whole side of the air quality management problem that we simply don't discuss which is people and behaviour"...Yeah, I might have given you a little bit more budget, maybe." -CC11(S)

"I think there's been quite a bit of feedback in terms of people saying they really liked the fact I took the time to deliver the sensors and stand there and chat to them. I think having that - it justified having that human interaction and that human dimension." -WC9(S)

In terms of negative experiences, for WeCount the predominantly online format limited opportunities for collaboration, deeper process understanding, and conflict resolution. For ClairCity, training challenges were associated with the Delphi process (N= 5), deemed unsuitable for the target audiences, recruitment issues stemming from messaging and messenger misalignment (N= 4), and the standardised design of the programme, which restricted adaptability (N= 2). "The differences are much more pronounced than I had expected between the cities, and you cannot make such an overall approach as we did. It has to be more tailormade per city and this one-size-fits-all wasn't the ideal approach. We've adapted a lot, but it should have been from the beginning in a much more adapted way." -CC5(C)

Enjoyment Despite initial concerns, many found dialogic, co-produced forms of engagement enjoyable (N = 13; 48%). Enjoyable in terms of having deep and meaningful conversations but also in terms of challenging assumptions and being able to see, first hand, how they were contributing to citizen empowerment and democracy.

"Yes, I think for us it was the first time that we went on the streets and put on our ClairCity t-shirts that we specially made to talk to everybody. It was new for my staff and they liked it, they loved it, which was really nice, it's nice to do." -CC5(C)

"With science, citizens are often excluded from the science and just get the numbers at the end, but to allow citizens to be part of the process to generate those numbers, to understand their local context, I think that is incredibly valuable. What I like doing is helping people do that so from that perspective I absolutely loved that, yes." -WC10(T)

5.2.2 Competency development

In this domain, interviewees reflected on the abilities needed for empowering PE and cognitive, behavioural and affective learnings.

Character traits Eight interviewees (40%) mentioned PE character traits required, either from personal experience or observation. These included mood (e.g., being friendly), passion, authenticity, patience, and charisma. While some believed these could be learned others felt they were natural attributes that only certain individuals possess.

"You have to be passionate; I think you shouldn't answer bad, you shouldn't press the people because maybe he'll pass by and say no but after the second time, maybe if you smile and you're yourself he'll see you're not false... they feel it. For that reason, I think not everyone can do engagement." -WC7(S)

Knowledge, understanding and skills Knowledge and understanding were inseparable from skills development due to the applied nature of the programme. 25 (96% of all participants, 19/20 novices) reported learning something new during the process. Only one researcher and one policymaker did not develop their learning or skillset, either due to existing competence or lack of participation. Key learnings included cross-disciplinary insights (N= 11), communication (N= 10), social science (N= 9) and digital skills (N= 4, WeCount only), engagement tips (N= 9) and audience insights (N= 9).

"Everything has been new for us... Even the social media use. We've learned about ... the need for consent forms and ethics." -CC1(C)

"I think too often as academics, we have a tendency to preach, and ... we have a tendency to imprint our visions and our ideas on top of other people. Certainly, what I got out of those engagements ... was the value of listening, and the value of actually not only listening, but hearing the challenges that people had." -WC9(S)

"The perception has always been that citizens don't necessarily understand the problem of air pollution and the impact it's having or the effects that they are having on it, how they're contributing to it and how they can do something about it. What I did get very clearly from the responses was that people are very aware of air pollution and also very aware of their contribution to it too and would like to do something different." -CC9(S)

Attitudes and values Six (30%) novices expressed shifts in PE perceptions during the programme of either their own or their colleagues. Whilst before they may have viewed the public as subjects to be instructed, after the programme they viewed them as fellow collaborators with similar learning needs (motivation, autonomy, scaffolding) and unique contributions (on challenges, analysis, barriers, visions, and solutions).

"Before, I was thinking about how to go to people and to say what we are doing but now also how to go to people and learn from people about their daily routine, their thoughts, their behaviour etc, and how to learn from it and to bring it with our classic approaches of work, for instance." -CC4(S)

"It has changed the way I think about the air quality issues and the framing. Why is pollution created, what are the activities rather than it being more about the technology. This slight shift in framing could be useful in the future." -CC8(P)

"It was probably more of a wake-up for policymakers, which is obviously really useful for this project, to challenge that perception and think that actually people are in the know probably more than you are, to a certain extent, and are more receptive to change than you might think."-CC9(S)

In some cases, this attitudinal shift led to value changes in themselves (N=3) and potentially to policymakers they engaged with (N=2).

"If I knew then what I know now I would have created a bigger budget [for PE]. I probably didn't leave enough budget and enough time for getting out to the harder to reach communities." -CC11

Lastly, one specialist gained a "new-found respect" for social science within environmental research. While they are not interested in incorporating PE into their role, they now see the benefit of including such specialists. "The whole methodological process...it's opened my eyes completely to [what] I thought I knew what social science...I've also learnt a lot of what I don't know too and a new found respect for social science in its widest spectrum ...There's much more theory about it which I hadn't really got to grips with ...so I think if I've learnt anything it's not to try and do it myself but to try to employ somebody who can." -CC9(S)

Behaviour, actual and intended: new framing, relationships and actions In terms of behaviours, N = 8 (40%) participants, N = 7 from ClairCity, stated changes they had made in response to the training with another N = 8 (40%) stating intentions. These consisted of plans to value PE more in future research/policy (N = 6) and to participate in similar projects/use the methods (N = 3) and changes in how they communicate with audiences (N = 5), and in their prioritisation for PE (N = 2).

"Tools and methods applied were very appealing for me, they turned out to be effective and I will definitely use them in my work with residents on other occasions. My department in the City Hall plans to take advantage of these methods during consultation with citizens and policymakers on proposals of infrastructure projects to be submitted for EU funding." -CC16(P)

"I think the biggest change was even the opportunity to talk more. [During talks and interviews] the main message I try to pass is don't expect that technology will solve the problems. We need to change citizens' behaviour, so we need to focus on education and so on, so I am very concerned now about education and citizens."-CC12(S)

"I was at a conference [where] everyone in the conference was there going about "it's all about the science-policy dialogue" ...and I just kept going, "no there's a third strand to that which is the public" and I would not have said that four years ago." -CC11(S)

Four (20%) did not mention behavioural change/intentions. For one, it was because they were not involved in the delivery of PE, while another it appeared attributed to a negative experience with the sensor. For the other two, both contextual factors (as discussed above) and their contradictory views about the public may have influenced this. For example, CC5 initially expressed the belief that the public was "not interested" in environmental issues, but later contradicted themselves by stating:

"It wasn't all negative. We had some very nice insight. I was surprised how positive people are about a green and a clean city." -CC5

Lastly, in ClairCity interviewees were asked about their pro-environmental behaviours. Eight novices and one PE expert (56% of 16) mentioned that they adopted more because of the project (e.g., raising awareness, switching cars/boilers, joining air quality monitoring networks). Seven (44%) did not change as they already saw themselves as pro-environmental.

6 Discussion

This study addresses several critical gaps in the literature regarding effective co-production and deliberation. First, it explores participation from the inside out – from the views of those initiating such programmes and how and if, through PE delivery, these views change over time. This is crucial for understanding how power imbalances can be better addressed in decision-making while recognizing the value of experiential and situated knowledge (Turnhout et al., 2020).

Previous attitudinal studies have tended to focus on scientists' static views in relation to informative PE approaches (Copple et al., 2020; Yuan et al., 2017, 2019). This study explored their and other stakeholders' views in relation to empowering approaches and how that changes through repeated action and reflection. Not just the reward (Besley & Down, 2024) but the challenge of participating in PE, combined with a supportive learning environment and context enabled many novices to change their PE behaviours, attitudes and values. While this was not universal, many gained skills (efficacy) and networks that may lead to further their PE learning and support. While scientists and policymakers may have limited interest in two-way communication approaches (Shaw et al., 2018; Yuan et al., 2017) this study shows many are open to changing their views with the right conditions and opportunities. Indeed, evidence from PE projects demonstrate how policymakers are increasingly taking on networking, stimulating, and facilitating roles, particularly when provided with adequate support and flexibility within their organizations and assurance that social inequalities will not worsen (Mees et al., 2019).

Second, this study used a competency approach to learning necessary for just processes and outcomes (Cornips et al., 2023; Tuurnas, 2020). Often overlooked in competency studies, it further identified enjoyment and character traits as additional mediating factors in learning (c.f. Wong, 2020). While literature often assumes all environmental decision makers should seek to empower the public not all find the process enjoyable or feel suited for the role. Co-production literature has long emphasized understanding the heterogeneity among citizens (Besley & Nisbet, 2013); it is equally important to recognize these differences among specialists (Baram-Tsabari & Lewenstein, 2017; Besley et al., 2015).

Third, the study highlights various contextual and training design factors that influence learning and participation. While these dimensions have been studied separately in relation to scientists (Pidcock et al., 2021) and citizens (Pascual et al., 2021), this study considers how both effects learning potential.

Finally, this study assesses the quality of the training and learning environment. When designing empowering PE programmes, scholars point to the need for "situational, relational, reflexive, ethical, and mutual learning" among citizens (Murunga, 2022, p238). This study demonstrates that these principles should apply equally to those initiating and facilitating the programmes.

6.1 Recommendations

By examining both larger systemic and structural issues as well as meso-scale situated and smaller-scale social-psychological factors, this study offers a systems thinking view of how to broaden and deepen PE. Four key leverage points are outlined and the authors welcome further input from the PE community:

- Increase funding for social science research on global challenges: As highlighted by Overland and Sovacool (2020), funding in this area is very limited. Programme initiators should work with PE specialists to seek out opportunities, taking time to determine the time and budget requirements for training, engagement and evaluation to make co-production effective.
- Recognise public engagement as scholarly/political work: To increase the social acceptance of PE it should be viewed as an essential component of careers and evaluated as part of career progression (Kelly & Given, 2024). This should be accompanied by comprehensive training to help individuals fully understand and apply engagement approaches in their specific fields and research projects.
- Expand training beyond knowledge acquisition: Trainers must move beyond one-way communication models to include longitudinal, flexible, situated, embodied and reflexive PE practice for transdisciplinary research-policy teams (Tuurnas, 2020; Besley et al., 2018; Yuan et al., 2017) building on the programme in this research. Pre- and post-programme evaluations—covering interests, competencies, structural challenges, and the training process—should be incorporated to tailor offerings and assess impact. Lastly, creative engagement approaches co-designed with the public from the outset should be encouraged.
- Secure financial and political backing for empowering public engagement: Empowering approaches to PE must be supported by financial resources and political prioritization (Centre for Public Impact, 2021; Khatibi et al., 2021). Co-created PE strategies can support governments in enabling their citizens to take climate action, minimising backlash and costly adjustments (Orr & Powell, 2023). While dedicated engagement offices within councils create the necessary human resource to encourage cross-sectoral partnerships and continuity across projects. Examples include the Barcelona's Citizen Science office (CitiMeasure, 2022).

7 Conclusions

World leaders are obligated to empower citizens to be part of ongoing environmental decisionmaking processes. Despite this, little progress has been made towards realising true knowledge co-production. This study points to the need for in-depth, situated and longitudinal training among the initiators and facilitators of such processes (e.g., scientists and policymakers) to enable ethical and empowering approaches and support their acceptance of empowering PE methods.

Training consisting of a workshop, learning-by-doing, social support (group reflection and mentoring) and guidance documents supported 20 novices in this study to gain competence in PE. 96% of all interviewees gained new knowledge, understanding and skills with 30% changing their attitudes and values, and 40% changing behaviours relating to PE. The enjoyment of the programme, the space for reflection and various contextual factors influenced competency development, including the perceived suitability to perform PE. To scale this training further funding and institutional support is required, within academia and policy, as is the need for trainers to move beyond learning-to-know approaches and towards learning-by-doing with diverse knowledge systems.

7.1 Limitations

This study has several limitations and weaknesses. First, it relied on one data collection method captured near the end of the projects. No baseline data was captured, nor was

the level of participation in the training programme or demographics making it at times unclear how *a priori* factors may have influenced responses. The sample size was also small, with few entrepreneurial and consultative participants. Furthermore, inaccuracies in memory recall may have skewed results and there was no triangulation (e.g., with quantitative metrics) to mediate for this. Interviewees were also self-selecting, meaning those that had differing views and roles may not have come forward. Additionally, project teams consisted of white Europeans; future studies should test out the suitability of this programme in non-European contexts.

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Data availability Evaluation data for both projects are available on Zenodo. In the interest of anonymity, interview transcripts have not been made publicly available.

Declarations

Conflicts of interest The authors declare there to be no conflicts of interest with respect to this research.

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