

Article

RISING Strong: Sustainability through Art, Science, and Collective Community Action

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Abstract: The objective of this research is to offer a qualitative analysis of adult STEAM (science, technology, engineering, the arts and mathematics) learning in a community setting, with a focus on sustainability and climate action. To date, much research on STEAM learning has been directed towards youth and children in formal educational settings. Our qualitative study involving semi-structured interviews with community participants, artists, and scientists over the course of a six-month initiative in Ireland allowed us to develop a rich picture of a multi-faceted STEAM project that held space for both a social change agenda and a learning agenda. In our findings, we identified several contributing factors to transformative learning and changed feelings about climate change, including pride of place, the development of strong interpersonal relationships, and an emerging sense of collective agency through a shared emotional and affective journey. To design for meaningful, community-level climate action, we argue that learning may be supported in, with and through STEAM. Our study also showcases the value of the arts and aesthetic experiences to embrace dissensus when tackling a complex issue like climate change through STEAM education.

Keywords: STEAM education; climate; environmental education; equity; justice; informal learning; non-formal learning; place-based knowledge; science communication



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1. Introduction

Initiatives which combine the arts and STEM (science, technology, engineering and mathematics) disciplines under the moniker STEAM (science, technology, engineering, the arts and mathematics) [1] are emerging as valuable approaches to engage learners of all ages with “wicked” problems [2], such as the climate and biodiversity crises [3], and to create equitable opportunities for imagination and transformation [4–7]. Informal educational settings are ideal spaces to promote learning that is socially constructed. In such environments, conversations and collaboration can lead to transformative individual learning, promoting wider societal transformation [8]. Multiple authors have argued the potential for sociocultural learning through purposeful, community-engaged social action and social movements, in which participants develop identities, come to understand themselves as agentic, and remake their worlds collectively [9,10]. Much scholarship on STEAM education has focused on children and youth in formal settings [11–13], or youth STEAM learning in informal, community settings like afterschool programmes or makerspaces [14,15]. Relatively little literature exists, however, that examines the ways that sociocultural learning is manifest for adults in informal settings that combine the arts, STEM, and social action.

This article describes such an instantiation of adult STEAM learning in a diverse but geographically connected urban community in Ireland, whose members navigated differing worldviews to collectively tackle climate and sustainability issues in their locality. We make use of theoretical frameworks related to STEAM [1,16], arts-led sustainability education [17], and climate action [18] as lenses to examine this case study: a funded

programme promoting behavioural change and positive climate action involving a research-intensive university, a socially engaged theatre-making company, and local adult residents in the vicinity of the university. Through the unique programme described in this study, an equitable pathway for expression emerged, in which participants worked through the tensions of dissensus [19] to make personally meaningful behavioural changes that remained true to their own values while learning from the perspectives of others. In this context, STEAM supported transformative learning, community engagement and activism around the focal point of climate change and environmental care. With this study spanning the porous boundary between science communication and informal science learning, we aim to add to the evolving understanding of the fields of STEAM and art-science research and practice. We contribute insights from this particular context, which offered a culturally connected community the opportunity to draw on disciplinary expertise and approaches from STEM and the arts to author their own stories of sustainability transformation.

In Section 2, we introduce the background and context of this study, along with the theoretical frameworks which have informed our inquiry. In Section 3, we outline the generation and analysis of qualitative data captured through semi-structured interviews with seven programme participants: one artist, three scientists and one project coordinator. In Sections 4 and 5, we present our findings and a discussion of them, highlighting the potential for varied configurations of STEAM programmes with diverse participants to advance equity and social justice.

1.1. Art-Science and STEAM Learning

We situate our research on transdisciplinary adult learning in informal settings within the emerging field of art-science or STEAM. Bevan and her colleagues [16] describe the central role that purpose and meaning play in driving the formation of identities as individuals and as members of connected communities. They present a framework of conjectured epistemic practices of STEAM, drawing on sociocultural theories that value learners as powerful, agentic individuals who participate in consequential and purposeful activities within their communities [20]. These authors and their colleagues further advanced the theorization of STEAM, covering the emergence, history and contested nature of the term STEAM [1]. They offer four helpful rhetorics of STEAM using axes of pedagogical and instrumentalism. The instrumental axis helps to differentiate between one-sided instrumental approaches to the combination of STEM and arts disciplines in which one discipline is in service of another and a mutually instrumental approach which “frames all disciplines as equal and in dialogic conversation, making the motivation for STEAM one based on transdisciplinarity” (p. 218). The pedagogical axis serves to differentiate between initiatives which place learning and engagement at the centre, in contrast to settings in which the practices of STEAM are non-pedagogical—for example, in popular culture. These authors place particular focus on approaches which occupy the quadrant of their work that represents pedagogical and mutually instrumental, as being powerful settings for transformative learning. Likewise, Burnard and Colucci-Gray [21] argue for the need to move from STEAM as a contested term to the “enactment of paradigm-shifting moves of rethinking STEAM as transdisciplinary education” (p. 3).

1.2. Arts-Based Methods in Climate Change and Sustainability Education

In a call for an increased focus on sensory aspects for improved sustainability learning in higher education, Harald Heinrichs reminds us that “humans are not only cognitive information processing machines but multisensorial beings constituted by complex, interrelated cognitive, emotional, affective, corporal conditions” [22] (p. 5). He argues that one role of arts-based approaches is to reflect and focus “aspects of human behaviour in socio-environmental contexts” (pp. 12–13). Mutually instrumental STEAM approaches that draw on climate and environmental issues as contextual framing make particularly valuable learning settings—as Anne Pirrie puts it: “Reconceptualising the interrelationship between sciences and the arts has the potential to enrich our understanding of science, revitalise our teaching and make us open to

new ways to respond to environmental challenges” [23] (p. 19). In her essay in the same volume, Laura Colucci-Gray argues for the increasing importance of “*embodied, situated knowledge*” in tackling complex science and technology challenges, and positions STEAM as “*as part of an extended ecology of material, affective and cognitive relationships*” [24] (p. 105). Much of the emergent scholarship on STEAM or transdisciplinary approaches to learning draws on the critical research traditions of Science and Technology Studies (STS), taking on concepts of entanglement and kin-making between the lives of humans and our more-than-human counterparts [25], as well as anticapitalist and decolonial practices and collaboration within multispecies assemblages [26]. These offer particularly useful lenses to frame an ethics of care [27] in working towards life on a damaged planet [28].

In our study, we also draw on the framework presented by Julia Bentz [17], which aims to “*support meaning-making, create new images and metaphors, and bring in the wider solution space for climate change*” by highlighting the opportunities afforded by learning *in*, with and through art. Within this framework, the first level is described as learning *in* arts and humanities settings and is characterised by the learner engaging with or creating materials or artifacts relating to the climate crisis—this may include scientific or factual information or materials, serious games, drawings or illustrations. Ref. [17] draws attention to the transformative potential of learning *in* arts and humanities settings when integrative discourses are used that highlight the complex nature of climate change as situated within a wider interacting system including societal, political, economic and environmental dimensions, informed by values and worldviews.

Learning about climate change *with* art is described by [17] as being participatory and experiential, with a strong focus on learning across disciplinary boundaries, and social-emotional learning. Learning with art leads to opportunities for critical self-reflection, the taking of multiple perspectives, and promotes learner responsibility, drawing on the Freirean notion that “*responsibility cannot be acquired intellectually, but only through experience*” [29] (p. 13).

The final level in this framework is learning about climate change *through* art, which is a fundamentally transdisciplinary endeavour, not only drawing on expertise and defined practices from different disciplines, but welcoming input from holders of multiple forms of knowledge in the process of creating new meanings. This level involves co-creation on a non-hierarchical level, and makes room for differences, variations and tensions among participants, leading to learning for all participants, not only those in the more traditional role of learner or student within a learning environment, but also those in the role of educator, facilitator, or other contributor. This echoes the conceptualisation of “*learning through the arts*” presented by [30] as learning beyond the specific techniques required for individual disciplines, and towards a more general knowledge. In this study we identify examples of each of these three levels of the framework of [17] within an adult climate action project.

1.3. Climate Change Education and Communication

Recent research led by the Yale Program on Climate Change Communication in association with the Irish Environmental Protection Agency indicates that the Irish public is well informed about climate change, and highly aware of the human causes of it [31]. This research also indicates that engagement levels are high among the Irish population, with over 70% of the 4000-strong representative sample discussing climate change with family and friends at least occasionally. However, a separate study in Ireland indicated that understanding of the relative mitigative effects of different individual climate actions is poor [32]. Research into climate change communication indicates the effectiveness of approaches which are localised and draw on strong human attachment to place as a means to promote environmental or climate concern and action [33]. Drawing on insights from neuroscience and psychology, De Meyer and co-authors [18] advocate for approaches which deviate from the more typical “*issues-based*” framing of climate change, and instead

embrace “action-based storytelling”, whereby positive stories of people engaged in relatable real-life sustainability practices help to generate agency within wider audiences.

Numerous authors advocate for creative, community-level action on climate change e.g., [34], with many pointing as an example to the resilience of communities in the face of adverse weather situations [35,36].

Boda [37] calls attention to the variable and ambiguous use of the word “community” in sustainability research and presents a useful heuristic for defining community within any given study under the headings of 1. Ontology and Epistemology; 2. Methodology; and 3. Motivation. Based on this heuristic, our study relates to a community of interest with an ontological status defined by shared commitments to positive, local climate action. The group is conceptualised by self-identified members, and our study uncovers the motivation of the group to examine potentially conflicting or synergistic viewpoints in relation to sustainability, mediated by artistic processes.

1.4. This Study

Informed by the research discussed above, we contend that a combination of the arts, science and collective community action can lead to proactive citizen engagement with climate action. Our study aims to address the following questions: (1) How might a STEAM programme in a community setting with adult participants provide a meaningful avenue for transformative learning and action on climate change? (2) What can insights from a community-based programme focused on climate change contribute to our evolving understanding of transdisciplinary approaches that blend STEM and the arts?

2. Materials and Methods

2.1. Study Context

This research was undertaken as part of a socially engaged project entitled RISING, which brought together a group of concerned citizens to creatively take action on climate change in their locality, an urban area close to the main marine port in Dublin, Ireland, locally known as the “docklands”. The docklands have undergone rapid transformation in recent decades. While labour in the docklands industries was traditionally the route to employment for many local residents, this has been surpassed by the new technology and financial corporations now based in the vicinity. Some of these large multi-national corporations inhabit a neighbourhood which has faced social problems and a huge decline in population since the suburbanisation of Dublin, which began in the 1960s. A community resident interviewed for this study recalls a tragedy in 1963 as tenement buildings collapsed, resulting in the deaths of two young girls. This led to forced depopulation of the area in the following decades, as the local government demolished sub-standard tenement housing and relocated families in the city’s suburbs. According to our interviewee Rosie, *“In the parish. . . we had approximately twenty-two and a half thousand families. And when the depopulation was completed, which took many years, it didn’t happen overnight, we were left with . . . less than six thousand people”*. Since the 1990s, the population of the area has grown again, as gentrification spurred on by the influx of the tech industry has led to *“the large-scale construction of private apartments and gated enclaves for middle- and upper-income groups”* [38] (p. 174).

A community engagement unit of a research-intensive university instigated the project. The university has a campus in the docklands and has operated a civic engagement programme there since 2018, opening a physical space in early 2020. A socially engaged theatre-making company were appointed as artists-in-residence in 2020 with a remit to work with local communities; however, their tenure was delayed until 2021 because of the COVID-19 pandemic. The remit of the granting agency was for projects funded under this call to spur behaviour change in relation to climate among the participants and their wider communities and it was aimed at adults rather than youth or schools.

2.2. Participants

A community manager employed by the university led the recruitment for the RISING project through the autumn of 2021. As the university's civic engagement space had only been open for a short time, it did not have a large cohort of regular attendees but had an established connection with a local community centre nearby. Following an event at a theatre festival, the recruitment drive aimed to get local residents to engage with the project by attending one of the three identical open-ended conversational workshops in November 2021. The promotional material mentioned that the project would lead to creative climate action in the docklands area. All attendees at the initial workshops were invited back to a series of weekly workshops held on Monday evenings from January to March 2022. From the 36 people who registered for the initial workshops, a core group of approximately 12 emerged who committed to the workshop series in 2022. Of these, seven participated in this study. The community manager, one representative of the artist collective, and three scientists from the university also agreed to be part of this study.

The theatre-makers noted the challenge inherent in both convening a group of people with no prior connection other than geographical proximity and maintaining connection with them during a six-month arts project. While they have vast experience of socially engaged practice, they mentioned the fact that in previous projects, they engaged with well-established groups, and so a significant part of their work in the RISING project was to develop trust among the group as well as work with them towards creating an artistic intervention.

The 12 core participants in the project represented a wide range of ages, nationalities, educational levels, and professional profiles. They all resided in, or close to, the docklands areas. Some had previous experience with activism, while others were active in voluntary roles within community groups and associations. The university scientists who were interviewed for this study had been involved in the project either to consult with the artists during their research phase, or to facilitate a workshop with the community participants. Two are senior faculty members, and one is a postdoctoral research fellow, all active in areas of sustainability science research. Table 1 indicates the participants and their roles in the project (all names are pseudonyms).

Table 1. Research participants grouped by roles in the RISING project.

Role	Name *
Community participant	Susan
	Christina
	Rosie
	Sam
	James
	Therese
	Maria
University staff	Sarah
	Jake
	Louise
	Ian
Artist/facilitator	Rebecca

* Participants have been assigned pseudonyms.

2.3. RISING Project Phases

RISING took shape in four distinct phases. In the first, the theatre-makers worked with university researchers to develop a script for an immersive audio-visual production that was staged as part of a theatre festival. Following the theatre festival, the university invited local participants to a series of information sessions about the next phase of the project. A group of approximately 10–15 adults formed to participate in the subsequent programme, which involved weekly meetings over four months. The sessions included creative workshops with artists and guest lectures with university scientists. During this

time, the participants coalesced into subgroups for the third phase, in which they undertook their own climate action initiatives: a public edible garden, a campaign to reduce light pollution, another to tackle litter, and an anti-greenwashing campaign aimed at large corporations based in the area. The creative element of the programme was facilitated by the theatre-makers, who utilised the real conversations of the participants to devise a script for the final phase: a public-facing presentation professionally staged over two nights in a local theatre featuring many of the community participants.

2.3.1. Initial Audio Production

The initial phase of the RISING project was the development of an immersive audio-visual experience, which premiered at a theatre festival in October 2021. This was a site-specific outdoor experience. Audiences were invited to a location along the banks of the river Liffey and were asked to use their mobile phones to listen to a specially developed audio production with script and sound design by the artists and performed by a young local female actor. Simultaneously, a light installation displayed a series of texts and animations on the walls of the adjacent quays. The actor narrated this 20-min piece, the script for which was informed by the artists' background research in which they consulted climate scientists at the university, including Louise and Ian. The piece imagines a future in which no action has been taken on climate change and reflects on the impacts locally in the Dublin docklands, across the water in Wales, as well as on a global scale (see Supplementary Materials for details on the audio production).

2.3.2. Series of Workshops and Inspiration Sessions

The series began with an initial workshop in November 2021 that was repeated on three occasions, in each case opening with the audio production. Many of the attendees at these sessions were visibly moved at the conclusion of the audio piece, with one participant remarking that it should be shared on social media with every young person in the area to encourage climate action (Figure 1d). The subsequent workshops were held over two hours every Monday evening for three months. These were held primarily in person, with a small number held online due to the re-emergence of COVID-19 restrictions in early 2022. The general format for these sessions was a combination of creative exercises facilitated by the artists, as well as a contribution from a guest speaker, either as a lecture or an interactive workshop. The community manager and the artists worked to identify and arrange guest speakers. These were generally individuals active in areas related to climate change, biodiversity, environmental protection and sustainability, including university staff members or representatives of local organisations. The approach to programme development was fluid and shaped in response to participant interests. Speakers were generally not determined until a few weeks in advance of the workshops. Participants were informed early on in the process that the end goal of the project was twofold—for them to undertake some local climate action as well as some sort of creative output in April 2022; however, the format for this final output was not settled by the artists until a few weeks before the end of the project. The creative elements of the weekly workshops facilitated by the artists were varied and included individual reflections (Figure 1), group dialogue and creative writing (Figure 2), as well as embodied arts practices including walks and exercises drawn from improv theatre.

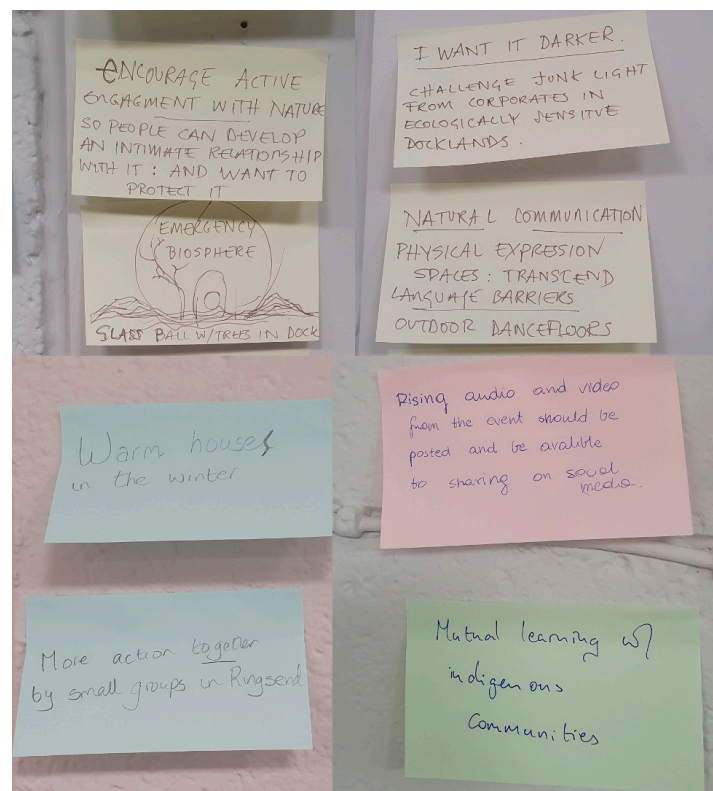


Figure 1. Climate concerns and ideas for action shared by community participants on the “Wall of Change” during a brainstorm session as part of the initial RISING activation workshops.

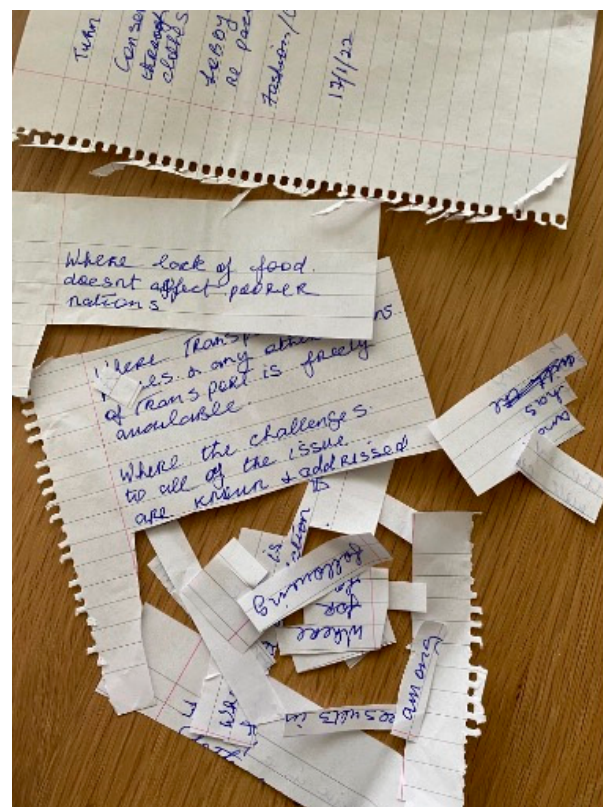


Figure 2. Sample of deconstructed creative writing generated by a community participant during a RISING creative workshop.

2.3.3. Community Climate Action Projects

Following on from initial individual and group reflections on the climate crisis and potential actions in the first workshops, subsequent sessions allowed participants to determine their own preferences for which local climate action to take. Four main thematic areas emerged, with participants naturally aligning themselves with one of the following:

- Greening the area;
- Tackling litter in the docklands;
- Campaigning for corporations to act sustainably;
- Light pollution.

In March 2022, the inspiration sessions changed to action sessions, with the entire group splitting into smaller groups during the Monday evening workshops to make progress towards their goals. The greening group created an “edible garden”, planting herbs in a public space for local residents to use freely. The group tackling sustainability in corporations created a manifesto and a short film to share their message. The light pollution project (involving only one person rather than a group) worked with university scientists to investigate the effects of light on nocturnal animals and developed plans for a citizen science project. The litter group worked towards transparency and accountability around the upkeep of public spaces in the area, contacting local government as well as property management companies. Throughout this phase, the artists and university community manager continued to support the participants by facilitating group discussions and feedback sessions. The university provided some financial support to the groups through the project funding, and the community manager assisted in making links with relevant university researchers as necessary.

2.3.4. Stage Presentation

The series of activities in the initial phases led to the adoption of devised theatre as an approach to be used for the culmination of the project. The output of a devised theatre approach is a work which has emerged through a generative collaborative process between a group of people, with the ideas originating from within the group, rather than the interpretation of an existing text [39]. The devised theatre piece was developed collaboratively, based on conversations which had occurred throughout the entire series of workshops, as well as written contributions made by the participants during the brainstorming and creative writing sessions (Figures 1 and 2). This was staged on two consecutive evenings in the university theatre, also based in the docklands area close to the civic engagement space. Despite this being a long-established venue, some members of the community participants mentioned during their interview that they had never set foot in this theatre prior to the RISING presentation. Both events were booked to capacity (80 people per night). The presentation was staged as a debate, with the participants playing themselves, mainly sitting at two separate long tables. The script was broken into sections, with one part featuring an individual community member at the centre of the stage. The artists also developed professional-grade lighting and sound design for the piece.

2.4. Data Generation and Analytical Techniques

This qualitative study draws on semi-structured interviews with 12 participants who were involved as facilitators, artists, scientific contributors, or community members. Interviews were held in May and June 2022, and lasted approximately one hour. Two researchers (the lead author and a master’s student in the university) were present for the interviews with the community members. The interviews with the artists and university staff were carried out by the lead author only. Six of the interviews were online and six were in person. The lead author had a role as an evaluator, and provided an evaluation report relating to the project as required by the funder [40]. All participants provided informed consent to participate in both the evaluation study, and this research. Alongside the semi-structured interviews, the scripts from the audio production and the final presentation are included in this dataset, as well as responses from a short survey carried out over Zoom in January 2023,

and researcher fieldnotes and memos from RISING events between November 2021 and June 2022. The semi-structured interviews covered topics including the history of weather events and climate in the area, experiences in the RISING project, personal relationship with climate change, and hopes for the future in relation to the RISING community group and to climate action more broadly. As the researchers had been present on a number of occasions throughout the RISING project, they had established some connection with many of the participants prior to the interviews, and so the tone was conversational. Interviewees were invited to add any extra thoughts or to take the conversations in directions of their choosing. One participant in particular (Rosie) provided a rich oral history of community activism in the area.

Interviews were transcribed and data were analysed using the reflexive thematic analysis approach of Braun and Clarke [41]. Chunks of text were coded initially by two researchers using broad “open codes”. These included: nature and the environment (land/water/wildlife/weather); climate change and sustainability; family; community; place; history; local and national government and policies; corporations and businesses; COVID-19; economic situation; education and learning; activism; (in)justice; the arts; emotions; youth; the future of the RISING group; and personal competences. These codes were grouped, and during an axial coding phase, the research team considered patterns of meaning and meaning-making across and between the codes, with the aim of generating “contextual and situated knowledge” [41] (p. 79). Following a reflexive, iterative process, the following themes were settled upon:

- Place-based knowledge and identity. Characterised by participants describing ways of being and knowing that have been shaped by the places they currently or previously lived;
- Perspective-taking and empathy. Characterised by the participants considering the viewpoints of others, or describing activities which made it possible to do so;
- Emotional journeys. Characterised by participants experiencing emotion and affect as a result of the RISING project and their changing relationships with climate change;
- Collective agency and response-ability. Characterised by participants, in relation with others, experiencing the ability to respond to or to transform their surroundings, or the activities that made that condition possible.

We (the authors) hold roles as faculty members in the university involved in the RISING project and are researchers active in the fields of science communication, STEAM learning, and education for climate and environmental justice. This positionality likely influenced our interpretation of the data, and the ways in which we assigned meaning to the stories shared by the RISING project participants.

3. Results

In this section, we share insights from the participants in relation to the entire RISING experience, under the headings of three key themes which we identified in the data: place-based knowledge and identity; perspective-taking and empathy; and emotional journeys.

3.1. Place-Based Knowledge and Identity

Among the participants interviewed, a key driving factor in commitment to RISING and the depth of the connections created through the project was a strong attachment to place. Many expressed pride in their identities as residents of the Dublin docklands area, with some having generations of history in the area, while others were more recent arrivals. The changing nature of the community in the area was remarked upon by Rosie, saying *“they’re a different kind of local people, they’re local people but they weren’t born and reared in the area. They’re living here, but they’re not from the area, but they’re interested”*. Rosie also described a deeply ingrained mistrust held by local communities towards both the university and the larger multi-national corporations, attributing this to a history of broken promises. Many of the interviewees referred to the challenge for communities living alongside large corporations and the need for all residents of the neighbourhood to enter into dialogue to

collectively address the shared issue of the climate crisis. Despite the changing population demographics described by Rosie, and the perceived divide between established and more recently arrived groups in the area mentioned by a number of other participants, RISING transcended these boundaries and created community among a diverse group of residents, united through a shared attachment to their local area.

Attachment to place also extended to the more-than-human elements, with many interviewees expressing strong sentiments of care for nature and the environment and expressing fear about the effects of pollution and the changing climate on the local wildlife. Multispecies care was manifest in one of the climate action projects undertaken by the participants. One member of the RISING group (not interviewed for this study) lives in a houseboat in the docklands and is an avid diver. Her climate action within the project was instigated as a result of noticing the effect that constant lighting from the nearby office blocks was having on the nocturnal activities of the otters that she shares the canal with. The story of this interspecies struggle against human-made light pollution was featured prominently in the final stage production to great effect.

Therese mentioned the intergenerational knowledge of the rhythms of the sea and patterns of weather held within her community:

“Well, Ringsend is, we’re all ex-dockers, fishermen, sailors. . . And so, they would know when the incoming tide and ebbing tide would be coming in and out. . . During the months or certain times, times of the months you’d have the spring tides. So, then you know, okay so say this month is May, you might have a spring tide at the end of May and we have maybe a bad storm coming in on that high tide and heavy rainfall, maybe over 24 h. You’re going to have a lot of rainwater coming down from the mountains, River Dodder, flooding, water running out into the River Liffey. So, I think it’s over centuries the fishermen in Ringsend were kind of clued into timetables. And we’re all kind of seaside or living beside the seaside, so it’s kind of in your nature that you know the timetables”.

The history and geography of the area was also frequently remarked upon by interviewees, and the fact that much of the area was built on land reclaimed from two river estuaries in centuries past. The artists made use of this environmental history as well as local pride of place in developing the script for the initial audio production:

*“Where you are standing used to be under the water, before the humans moved in.
We built up the sea walls to hold back the tide.
We evicted the indigenous biosphere, and we built ourselves a technosphere.
Is it ok that I’m ok with that?
You see, I’m from here.
This entirely us-made environment is my home.
My community.
Where my family and friends live.
Where I am growing up.
A place I love, despite its unnatural nature”.*

[Excerpt from RISING Audio Production]

This finding echoes those of [33]—a strong human attachment to place is a positive means to promote environmental or climate concern and action.

RISING as a title for the project was an effective and multi-faceted metaphor for local action in the Dublin docklands. It not only referred to climate change and rising sea levels, but also contained a nod to the Irish rebellion against British rule in Dublin in 1916, known as the Easter Rising. This event, and the subsequent War of Independence have been brought to the fore in Ireland in recent times as a “Decade of Centenaries” has been marked by a series of public events. The docklands were a strategic area of importance during the Easter Rising, and this history was referred to in the script of the stage presentation:

“Will we rise up? We’ve risen up before. We’re known for it around here. We named streets after rebels. Like the street I live on. Used to be called Great Brunswick Street. When it was time to rise up, it was this community and communities like it. It’s time to rise up again. Not for a flag. Not for a nation but for our planet home”.

In his interview, Sam poetically described his personal understanding of the metaphor of RISING as the need for humanity to transcend individualism, and to harness collective good for one another, and for our environment: “we are rising ourselves to something bigger. . . So then at the end of the day, it’s not just addressing climate change, but it is to go for something that is bigger than us. And somehow the environment is bigger than us, it’s more beautiful. We rely on it”. The ability of art to use novel metaphors to inspire and to interpret life on a changing and damaged planet is one of the central themes reported by Julia Bentz and collaborators in a study of a community climate theatre project in Portugal [42]. In the same way, the concepts underpinning the term “RISING” served as a novel metaphor with local and global relevance.

By creating projects that improved life for humans and more-than-human others at a very local level, many of the participants chose to leverage their own love for their home area, and focused on creating responses to the global level problems as tangible changes that would impact others in their wider communities—such as growing food in a public space. They brought varied assets and resources to this effort, from a seasoned community activist who provided connections into relevant local groups, to those drawing on experience in politics or media, and a musician who created a connective tissue between the diverse projects. These efforts demonstrate the myriad ways that pride of place can manifest in a community climate action project, beyond simply picking up litter on a street or stretch of coast.

3.2. Perspective-Taking and Empathy

RISING was aimed at residents of the Dublin docklands, and attracted a diverse group of participants, not only in demographic but also in terms of perspectives on climate change policies and approaches to climate activism. The ages of the group who gathered regularly throughout the workshop phase ranged from 20s to 80s, and many reflected positively on the fact that RISING offered them the rare opportunity to come into contact with others whose worldviews differed from their own. In reflecting on this, Therese described the way the members of the group became united around their shared concerns, despite their different approaches to climate action:

“...different people from different backgrounds just thrown together. And we all got on with each other. We all had our different views, but we all did the same thing we cared. So, when you kind of looked at... activism, could you see me getting locked up in cuffs, no I’d rather do something different. So yeah, I think we all brought something different to the table uniquely, individually”.

The theatre-makers explored and embraced the natural tensions that emerged within the group throughout the workshop phase. At an early stage of the process, they asked participants to reflect on the things they could do as an individual to take climate action within their own lives, and then asked them to reflect on what others should do—in particular nations, local government and major corporations. In opening up this line of discussion they invited participants to probe on a smaller scale some of the tensions in the wider climate change discourse [43,44]. This spurred intense debate among the group on what types of climate actions could be meaningful in terms of wider impact and shifting the needle on carbon emissions and global warming. A split within the group emerged, with a number of participants wanting to create a climate action project which would hold major corporations accountable in some way for their actions and call out greenwashing. Others preferred to create actions which would be visible and meaningful in their neighbourhood and which would offer a way for others to engage with the project and with climate action. Rather than forcing the participants to reach consensus and to coalesce around a single

approach, the artists supported the multiple viewpoints, and the groups continued with their actions in parallel. By creating multiple pathways for action and allowing the natural split between the local vs. global scale and individual vs. collective responsibility to feature strongly in group discussions, rich content for the final presentation was generated. Therese came to the realisation during her interview that the artists often deliberately provoked debate between the group, reflecting with some amusement *“I think they . . . were able to kind of push our boundaries on the chats. [ARTIST] was just throwing things in and just get everybody worked up and then walk away . . . an awful man for saying things and get us all riled up and then walk off”*.

A common theme during these debates was the level to which community action is worthwhile in the face of the global climate crisis. For some, it is futile in comparison to actions aimed at governments or industry, while for others, it was something they could feel control over, and allowed them to feel like they were making a difference for the lives of their loved ones. This was brought to the fore in the script of the final presentation, in which one of the voices declared *“We want to do something we have control over, that benefits people that we know and care about. We don’t have control over big corporations”*. In response, someone on the other side of the debate retorted: *“Well, you can dig around all you like in the dirt, I can’t see how that’s going to make much of a difference”*. This scripted exchange was based on real conversations and drew the attention of the audience to the fact that in wider society, these kinds of tensions can lead to acrimony among people who are actually working towards a common cause. Therese reflected on the power of the artistic experience, mentioning that after the final presentation, even though he knew it was a performance of a script, her father who had been in the audience was visibly affected and expressed his anger towards Sam for the way his character had spoken to Therese on stage. On the flipside, the stage show also captured the caring atmosphere generated among the group of participants. It demonstrated the fact that while debate was encouraged and dissensus embraced [19], this unique setting of an arts-led community STEAM initiative also encouraged participants to develop empathy for others by encountering alternative perspectives without being forced to abandon their own values. The same speaker who derided Maria’s community garden efforts later circled back to his previous remark:

“Just before we move on, I just want to apologise for my earlier comment about “digging around in the dirt”. That was uncalled for. It’s just that I think the situation has become so extreme that we need to concentrate our efforts on tackling the major offenders, the big corporations and the government”.

For many participants interviewed, the trust established within the group led to a sense of camaraderie, of being on a shared journey, and finding connection and kinship. Susan described a moment during one of the Monday evening sessions that was particularly memorable:

“Think it was just a little moment when I arrived in once, you know, work is terrible and you’re so busy and so tired. . . so, I come in here, after a day at work, and then somebody, Christina or Sam just squeezes my hand. Like, it’s just great, you know, we’re here to do this together. So that’s a super emotional moment. And I didn’t have to say anything. I just sort of was like, okay, and here’s where we can do something positive and here’s where we can do something, be really proactive, and here’s where we can be really practical as well, because we have the information. And it’s about people and humanity”.

Fun and humour were crucial in building this trust within the group:

“having such fun. Like I do remember thinking, laughing hysterically at each other because it was funny. People were very relaxed, especially after the first couple of weeks, you know, very relaxed and very much in a group. And then [ARTISTS] are brilliant at what they do because they let everyone’s personality come through. You know, for the first couple of weeks, people won’t naturally be themselves and will be kind of tentative or hesitant or shy or something or not trusting. So, I think, yeah, they built up the trust very quickly, very well”. [Therese]

The participants also recognised the potential for learning within such a diverse group. Susan recalled that when a journalist observed and interviewed the group, they commented on the fact that Susan's strategy was different to that of Sam.

"And I said, yeah, but that's on purpose because that's the inclusivity of the group. We will decide things as a group, but we support each other's strategies and we learn from each other's strategies as well". [Susan]

The workshops and guest lectures drew attention to bottom-up, grassroots and community-level climate action, as well as top-down, policy driven initiatives. These also allowed the participants to consider the effects of climate change at a local level by looking at maps of projected sea-level rise in the docklands as well as at a global scale, as part of a workshop on systems thinking. As well as spanning a diverse age range, the small group of regular participants in RISING hailed from or had lived in different countries around the world, including India, Ireland, Israel, Italy, Mexico, Venezuela and Zimbabwe. The sharing of these diverse life experiences served to contextualise issues of climate justice on a global scale—from Sam growing up in the shadow of a Venezuelan oil refinery, to Christina's experience of rural Zimbabwe and the ingenuity and resilience of local communities in the face of water scarcity. James brought his perspective as a seasoned politician to the group and shared his opinions on the need for a global shift away from our current economic models, and a rethinking of growth as measured by gross domestic product.

The overall experience raised questions for some participants as to whether they as individuals were actually doing as much as they could. After praising the RISING experience, Maria commented

"But what am I doing? I'm still flying. I'm still eating an awful lot of red meat. I still have my car. And to me, that's so much harder because it's actually easier sometimes to do activism, which was what was relayed in the piece".

The trust that emerged within the RISING group through community climate action and arts-based facilitation [17,42] led to strong relationships that were mediated by the ability to empathise with one another, and to learn from the diverse perspectives and experiences encountered within and beyond the group.

3.3. Emotional Journeys

RISING effectively combined personal and local narratives with reliable scientific expertise, leading to a final on-stage presentation that told a story of climate change focused on the positive actions of the community. This shift away from issues-based framing of climate change and towards storytelling featuring real people making a difference in their immediate environments has been suggested as a potentially powerful means of influencing climate-related beliefs, awareness and concerns, supporting the development of agency [18,34]. The project provided a supportive community-based frame that allowed scope for simple, convenient climate-friendly behavioural change for those who wanted to take a bottom-up approach, but also for large-scale activism for those who wanted to shake up political and capitalist structures contributing to climate injustice in the area. The focus on collective tangible action allowed participants to build personal efficacy and translated negative emotions into action rather than despondency. As Maria stated:

"I feel anxious and frustrated. I do have hope . . . I feel much more energised as a result of doing this project. You know, I have not yet taken the steps in my individual life that I should have taken in order to really consider my impact. But I feel energised by the people I've met, by their enthusiasm, by the fact that we did something. All of those things have contributed to a sense of agency".

Despite many differences, the core RISING project group coalesced around a set of shared compassionate values, driven by a shared will to do something for the greater good, rather than any political will or agenda.

“with RISING projects. . .there was no political will here. So, if we’re going to do something it is because we care about the community. So, this is there is not an influence of another bigger entity that then pushes us to go forward to something. So, there wasn’t an agenda, that’s what I’m saying. And not having an agenda and still being consistent in trying to address climate change, it gives you the best of the person. And yeah, we managed to have this beautiful project”. [SAM]

Evidence suggests that emotion is a strong driver of predisposition to environmentalism and climate action and that both factual and emotion-laden narratives about climate change can elicit negative and positive emotions [45]. Likewise, sharing personal stories of the effects of climate change has been shown to influence listeners’ beliefs about climate change and their understanding of the risks, with emotion playing an important mediating role [46]. In this study, we aimed to examine participants’ emotional responses to climate change. Thirteen members of the RISING group were asked in January 2022 “How do you feel about climate change right now?” and given the opportunity to select up to three responses from the following list: angry; curious; fearful; hopeful; anxious; optimistic; sad; inspired; guilty; frustrated. The results are given in Table 2.

Table 2. Responses to the question “How do you feel about climate change right now?” asked of RISING participants in January 2022.

Emotion	Number of Respondents
Fearful	5
Anxious	4
Frustrated	3
Angry	2
Guilty	2
Sad	1
Curious	2
Hopeful	3
Optimistic	2
Inspired	2

Interestingly, in January 2022, all respondents selected a set of emotions from either the ‘positive’ side of the list (hopeful; curious; inspired; optimistic), or from the ‘negative’ side (angry; fearful; anxious; sad; guilty; frustrated). No respondent presented mixed selections from these two groups. However, when asked the same question in May, there were a number of differences. Sam had responded “fearful; anxious; frustrated” in January, and while still frustrated in May, he ceded that “it brings optimism and a bit of hope when you see projects like this”. Maria had only responded “anxious” in January, but when interviewed in May said that she felt anxious and frustrated, but now also talked about hope: “I suppose those things can live alongside each other. You can be anxious and hopeful, frustrated and hopeful”. Therese had only responded “fearful” in January. However, she found that encountering new people and seeing the level of enthusiasm for climate action among the young people in the group led to a shift in her feelings about climate change:

“A little bit sad, I’d say with what’s going on. But more hope. And optimistic from it. Yeah, I was probably starting off a bit angry and pissed off and nobody’s doing that. But then I came away hopeful, knowing that it was actually young people in the workshop that care. So that was an eye opener for me”.

Research suggests that a progression of multiple emotions, or “emotional flow” from fear to hope supports and increases the persuasive effect of pro-environmental messaging [47]. The experience of the RISING project was a strong driver in shifting emotions in relation to climate change for many of those interviewed, and as indicated in the changing responses between January and May 2022, in many cases positive emotions appeared

alongside negative ones after partaking in the RISING project. This suggests the powerful ability of the arts to promote efficacy and to drive emotion and affect when used in climate change communication and public engagement.

3.4. Collective Agency and Response-Ability

“The houses that were not demolished were left derelict. So, for about 20 years, we were left with dereliction. And the docks were all derelict, warehouses derelict. No go areas”
[ROSIE]

“There used to be an Otter family here—but I haven’t seen them in a while. They hide all day and wait for it to get dark to hunt—but I guess it never gets dark enough these days. It’s daytime all the time, no time to rest, this is a workplace, and business comes first”.

[EXCERPT FROM RISING SCRIPT]

The terms “empowerment” and “agency” featured frequently in our conversations with the RISING participants. Many expressed the sentiment that the overall experience of combining community action and the arts, along with access to locally conducted scientific research, had given them a unique collective experience. Some, like Susan, Sam and Therese, described how this had given them the confidence and impetus to continue as a self-organising group and to extend their activities after the final performance and beyond the lifetime of the external funding source. Sarah indicated her intention to continue to support the group with access to the university meeting space. Susan described the ongoing group as becoming more empowered, remarking on their increasing agency to be heard within the locality: “we’re definitely empowered stakeholders now, I don’t see anybody refusing to listen to us. So that’s wonderful. But we’re still only a few months in”.

Supporting the participants to increase their own agency was one of the original goals articulated by the artists at the outset of the project. Louise, the scientist who contributed to the initial artist research phase, and then encountered the presentation as an audience member commented on the confidence of the messaging of the RISING group by the end of the project: “I think to be able to communicate something like that, you have to really be sure of it yourself in terms of developing your own narrative, whether as an individual or as a small group or community”.

In finding words to describe this theme, we drew on Donna Haraway’s [25] notion of entangled response-ability. Haraway mentions that differences in ecologies, economies, species and lives mean that we are “not all response-able in the same ways” (p. 29). While the oral history of the deprivation of the area shared by Rosie and the vanishing Otter family mentioned by the canal dweller paint a picture of communities and species who are less response-able than most in the face of ongoing climate chaos, the RISING project effectively opened up a space to tell stories that weave together situated, historical, embodied and scientific knowledge. And as Haraway reminds us, “It matters what stories tell stories” (p. 35). Climate change education within a relational materialist, response-able framing [48] allows for expanded possibilities for action, something which was referred to in this study by Susan as she reflected on the academic contributions to the RISING workshops: “We’re in a rare situation to have lectures, science lecturers who are connected with stakeholders in Ireland’s overall response to climate issues, come and lecture us weekly and you know, empower us with that information and ideas on what to do in response”.

4. Discussion

This study focused on developing an understanding of a configuration of learning at the nexus of art, sustainability science, and community co-creation and its potential to advance transformations for individual participants and climate justice within their locality. Adult participants engaged in a range of learning activities that were situated in their home area, active through their climate change projects, and embodied as a scripted stage presentation. The driving factors that maintained their engagement over a six-month period were pride of place, strong interpersonal relations, an emerging sense of collective

agency, and a shared emotional and affective journey. In this section, we discuss these findings in relation to three dimensions: learning about climate change in, with and through STEAM; epistemic practices and rhetorics of STEAM in a community setting; and finally, embracing dissensus in STEAM education.

4.1. Learning about Climate Change in, with and through STEAM

The role of emotion in driving behaviours related to climate change has been well documented [47,49], as has the potential of the arts to promote emotional responses in relation to climate change [22,42,50]. RISING led to individual emotional journeys as well as affective interactions [51] and intra-actions [52]. As described by Jan Slaby [51], affective interactions are relational: “either between two or more interactants or between an agent and aspects of her environment” (p. 59). Our findings demonstrate that the community setting promoted such affective interaction between RISING participants and aspects of their locality, including the rivers and the public green spaces in the residential areas. Barad’s notion of intra-action [52] is similarly evident through the emergence of agency as a result of the collective endeavours of the group in relation to one another and their surroundings.

Through its phases, RISING demonstrated all three levels of the framework of [17] described in Section 1.2. Learning about climate change *in* an arts setting occurred for over 600 theatre festival audience members at a specially developed audio-visual installation, which was reused as the initial engagement in the series of workshops that followed. Climate engagement *with* art occurred in the second phase of the project during the weekly workshops, when art was both the medium to facilitate and express learning. The final RISING presentation represented climate engagement *through* art. The script for this devised theatre piece was co-created with participants, building on the open-ended and personally relevant climate-related questions explored by them throughout the series of workshops and associated climate action projects and drawing on expertise from multiple disciplines, including scientists, activists and community leaders. As a public-facing work that spoke to members of the community, RISING answered the call of [33] to inspire others towards sustainable behaviours by telling stories of action rather than focusing on the factors that led us to the brink of climate collapse.

4.2. Epistemic Practices and Rhetorics of STEAM in a Community Setting

As a fundamentally art-science or STEAM project, RISING demonstrated many of the conjectured epistemic practices of STEAM presented by Bronwyn Bevan and her colleagues [53], as outlined in Table 3.

The above framework was developed in the context of out-of-school learning for young people, and is particularly useful in considering the potential for “pedagogical and mutually instrumental” STEAM learning environments [1] to advance equity and social justice for marginalised youth. Our findings indicate that this is also a useful framework for considering STEAM learning that happens in settings that are less clearly defined; within projects that occupy different locations along Mejias and colleagues’ instrumental and pedagogical axes [1] depending on their varying configurations. RISING was not primarily a learning project, yet learning was important to help the participants make progress towards their goals and was valued by participants. Therese remarked that she loved hearing from the guest lecturers from the university, and because she is “*not into school*”, she would have been unable to access this expert knowledge otherwise. Through the project and getting to meet one of the guest scientists, Susan was successful in obtaining a place on a climate-related course of study in the university. During a workshop on systems thinking, RISING was firmly on the pedagogical side of the spectrum. During the theatre festival, as audiences were invited to transport themselves into a speculative future, rather than advancing pedagogical aims, the intent was to provoke imagination and action on the climate crisis.

Table 3. Examining the RISING script using Bevan’s [53] framework of STEAM epistemic practices.

STEAM Practices		Example or Excerpt from Presentation Script
Exploratory practices	Noticing and questioning	Questioning the origin of the food they bought, or responsibility in relation to litter and light pollution.
	Exploring materiality	“We got our hands dirty”
	Defining the problem space	Deconstructing the problem space into areas of interest for each group (light pollution/food security/greenwashing/litter).
Meaning-Making Practices	Producing tentative representations	“I wanted to say something. And because sound is my thing. I made this. This was my response”.
	Conducting principled iterations or revisions	The use of devised theatre to generate multiple iterations of the final script.
	Engaging multiple modalities	Walks, improv theatre, creative writing, film-making, music, construction.
	Finding relevance	“I just want to say, it’s a comfort to me. Is that selfish? The concerns I have can cause me some anxiety. Sometimes it feels like a very lonely experience. I often worry that no one cares. or that my actions aren’t as impactful and that can be very overwhelming, so finding people who are passionate and worried makes me hopeful”
Critiquing practices	Critical historicity; Hacking the ideas of others	“Corporates and governments then, are brainwashing us, or attempting to, into thinking they are green and sustainable, through underhand marketing tactics. They are deliberately misleading us!”
	Cultivating dissent	“if you are an electrician, accountant, clerk, teacher, IT, an actor, and an artist no matter what profession you have, you can also be an activist”.
	Holding commitments to the standards of the field	Utilising top-level scientific advisors in the development of scripts and projects.
	Sharing results/“audiencing”	Public theatre presentation with professional lighting and sound design.

Quotes from the final presentation script are indicated in quotation marks in Column 3 of this table.

The stories told on stage at the culmination of the RISING project were created using the disciplinary expertise of the artists, who are acclaimed theatre-makers. They made use of arts-based approaches to capture the knowledge and wisdom of the participants that fed into these stories. Likewise, the artists and community participants drew on scientific knowledge as required to serve the goals of the project—for example, hearing from university researchers specialising in ecosystems and biodiversity when they were working on the urban gardening project. At these moments, the RISING participants made use of one or other discipline; in other words, they took an instrumental approach as needed. In assembling multiple knowledge systems in various configurations over the course of the project, RISING represents a unique instantiation of STEAM which defies categorisation in any one quadrant of the four rhetorics of STEAM advanced by Mejias et al. [1]. Rather, RISING embraced a fluid version of STEAM or art-science, drawing on the arts, sciences and pedagogical approaches as required by a community to meet their aims and ambitions. The result is a group and a project that worked to challenge cognitive injustice [54] and imagine a hopeful future for the Dublin docklands in the face of the climate crisis.

4.3. Science, Aesthetics and Politics: Embracing Dissensus in STEAM Education

Finally, our study highlighted the potential for STEAM in community settings to tackle “wicked” problems in configurations that draw on Rancière’s concept of ‘dissensus’ [19].

Rancière described his theoretical operations as being aimed towards “*reframing the configuration of a problem*” (p. 2), an approach which is of great significance during this time of climate chaos and environmental breakdown. Dissensus is not a conflict, but a neutralisation of hierarchy in terms of what is deemed common sense, a situation in which no standpoint is deemed as right or wrong, and no party forced to acquiesce to the other, but instead “*the staging of an excess, a supplement that brings about a more radical way of seeing the conflict*” [55] (p. 3). Tolbert and Bazzul [56] have similarly explored the potentiality of a turn towards aesthetics, politics and storytelling in science education, promoting “*a radical aesthetic shift in terms of what it allows students to see as visible, possible, and sensible in the world*” (p. 1). The findings of this study indicate that RISING centred multiple ways of knowing and sensing and showcased the dissensus experienced by the participants to a public audience through storytelling. Our study offers a small window into an instant of sociocultural learning that serves to disrupt and redistribute the sensible in STEAM education.

A limitation of this study relates to the fact that it was undertaken with researchers in the role of evaluators, primarily in an observational capacity, rather than utilising a participatory action research approach [57] and working alongside the participants to co-create new knowledge and social change. STEAM projects in community settings would benefit from a participatory design orientation, in which community members, learning scientists, artists, and university staff would engage in a participatory design-based approach [58], aiming for not only transformational learning but to probe for an understanding of how such transformations come to be. Attending to the pathways for humanizing, justice-oriented learning as outlined by [59] may be valuable towards these ends: (1) considering the goals of an equity-oriented framework for learning; (2) theoretically, drawing on existing critical social theory; (3) methodologically, focusing on collaborative change-making; and (4) supporting heterogeneity in knowing and doing.

5. Future Directions

As the effects of climate change grow, there is a need to find new methods and avenues to support climate learning and action. Climate communication requires more innovative and evocative formats to ensure that community learning and engagement are as diverse and accessible as possible, whether that is through traditional approaches like lectures and talks or more participatory approaches such as creative writing, walks, filmmaking, or improv theatre. This paper has demonstrated that transdisciplinary approaches that blend STEM and the arts can be especially powerful when implemented in a community setting with adult participants. The RISING project serves as an example of how artistic approaches, in conjunction with scientific expertise and participant knowledge, can create unique vehicles for participant learning and public engagement with climate change. More broadly, it showcases how STEAM programmes can be designed and implemented in ways that are equitable and non-hierarchical [1], with STEM and the arts equally serving the greater goal of community co-creation and the development of transformative agency [6].

A key feature of the programme was the fact that the community participants had full control of the directions it took, with the artists and facilitators drawing in scientific expertise as needed. This approach is vital as the impacts of climate change gradually affect all aspects of daily life. Initiatives that impose restrictions or limits on what a community should focus on are no longer fit for purpose. While cultivating community engagement from the ground up around shared interests is time-consuming and challenging, the eventual reward is the trust and confidence of a community to tackle the climate challenges they feel are most important. Critical to the programme was the embrace of dissensus so that participants could coalesce around different ideas rather than being pressured into reaching a consensus. Allowing for dissensus does not weaken the eventual outcomes but instead amplifies the agency of the group. Beyond the lifetime of the funded project, a number of participants connected with other existing movements and initiatives—further

community settings where they can share their experience of the RISING project and further develop their identities as creative climate activists.

Most importantly, the findings have shown that embracing diverse perspectives and creative approaches can lead to meaningful, long-lasting public engagement with climate action and can empower communities to take charge of their own responses to local challenges. Given how the impacts of climate change are growing more grave by the day and how its effects are disproportionately borne by the communities that are most vulnerable, there is a moral imperative to finding creative and equitable ways to amplify the voices of those most at risk.

Supplementary Materials: To access the publicly-available RISING audio production described in Section 2.3.1, go to https://risingdublin.ie/wp-content/uploads/2022/01/RISING_audio.mp3 (accessed on 14 August 2023).

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