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In order to meet the legally binding targets attached to the Paris Agreement (2015) and keep global temperatures below 1.5 degrees, Nations across the globe have developed and adopted ambitious climate targets which aim to reduce CO<sub>2</sub> emissions and support the net-zero emissions by 2050 scenario. The Intergovernmental Panel on Climate Change (IPCC) has stated that to avoid the catastrophic impact on lives, livelihoods and the planet, we must reach net zero by 2050 (IPCC, 2018. IPCC, 2023). However, reducing greenhouse gas emissions and limiting global warming will require deep-seated transitions in more than the energy sector; it will also require transitions in our economies, politics, institutions and governance processes. These trade-offs will undoubtedly impact people's lives, with many transitions requiring a significant behaviour change that touches on public values and remains deeply contested. Therefore, public consultation and community engagement are crucial if we build a public mandate for socially just transitions and trade-offs, ultimately creating policies that transcend into concrete action. However, it is also well-established that there remains a knowledge-action gap between climate research and innovation and concrete action; therefore, more must be done to reconfigure rigorous climate science to ensure that it is accessible and actionable for the general public.

### **The Climate Innovators Club at Glasgow Science centre**

The Climate Innovators Club was a community-based project undertaken with researchers from the GALLANT project and our community-based partners at Glasgow Science Centre (GSC). The project aimed to inspire young people and families from under-represented backgrounds into environmental science and STEM careers and help the individuals taking part better understand the environmental crisis through mission-oriented, effective messaging. Researchers from GALLANT, in partnership with representatives from GSC, used the five novel environmental science work packages previously discussed as a catalyst to engage with diverse and complex communities across Glasgow. This program used mission-oriented learning to provide new directionality for diverse stakeholders, address the knowledge-action gap, and make climate science more accessible and actionable while also forging new societal partners that aim to tackle climate challenges. Recent research has found that mission-oriented approaches to climate science can potentially allow for established research silos to break out of university structures, moving towards a whole systems approach ([Adshead. et al. 2023](#)). This reconfiguration of rigorous climate science is also known to make climate research more accessible and actionable- contributing to reaching new segments of society who are often not aligned with current scientific thinking and are underrepresented in climate research and STEM careers (Ibid).

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Researchers from GALLANT will aim to determine if the reconfiguration of climate research will support the conceptualisation of Glasgow-specific climate science, making it more accessible and actionable, addressing the knowledge-action gap while also forging new societal partners who feel more informed and able to address Glasgow-specific climate challenges. This project also aimed to identify the barriers under-represented groups experience in accessing and implementing climate science and the barriers participants face in accessing higher education. The Climate Innovators Club ran for 15 weeks across Glasgow at three separate hub locations (Govan, Govanhill and west-central Glasgow). The community collaboration research workstream in GALLANT which is the lynchpin between GALLANT science and local communities determined three hub areas in phase one of their community based activities, through consultation it was decided that the Climate innovators club would mirror these locations and seek to work with underrepresented groups from each of these three sites.

The prominent learning model adopted throughout the workshops was social development theory, associated with psychologist Lev Vygotsky ([1896-1934](#)); for Vygotsky, individuals learn through guidance and interaction with a more knowledgeable other. This more knowledgeable approach guides the individual through the zone of proximal development by reconceptualising complex theories ([Hargraves, 2021](#)). Learning experiences are enhanced, and higher mental processes, particularly critical thinking, problem-solving and logic, are extended through interaction with the more knowledgeable other (Ibid). Subsequently, the same individual feels more prepared to adopt higher-order thinking when encountering similar problems (Ibid). The Climate Innovators Club allowed early career researchers to participate in and lead workshops in partnership with the community engagement team at GSC; this supported the adoption of social development theory and higher-order mental processes.

## **Background- GALLANT**

GALLANT (Glasgow as a Living Laboratory Accelerating Novel Transformations) is an innovative project designed and delivered by research teams at the University of Glasgow and funded through the National Environmental Research Council (NERC). The overall objectives of this project are to use Glasgow as a living laboratory and ultimately design and test a scalable, translatable systems approach that delivers step change that begins to solve environmental and well-being challenges in cities and urban contexts. GALLANT has designed and is beginning to implement five novel natural environmental science work packages, accompanied by three innovative social science work streams. The five novel, natural science work packages have been designed with varying directives.

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However, the overall objective is to bring nature back into the city system, make meaningful and lasting change that embeds sustainability across significant policy decisions, empower communities and aim to ensure they are stewards of their local places and help Glasgow reach its aspirations to be carbon neutral by 2030- further information on the five work packages can be found below:

### **WP1- Flood risk- River Clyde/ Clyde Estuary**

The city of Glasgow, West-Central Scotland is situated along both banks of the river Clyde, 32 km from the river's mouth on the western Atlantic coast. Glasgow is Scotland's largest city, and the Clyde catchment area is home to 1.79 million people 33.8% of Scotland's total human population ([Clyde River Foundation, 2024](#)). Communities throughout the greater Glasgow region have a long history with the river corridor, it was once globally renowned for its shipbuilding and heavy industries with thousands known to be employed on the west side of the riverfront in places such as Clydebank, Greenock and Port Glasgow ([Anderson, 2022](#)). Decades on, the river corridor is experiencing new forms of regeneration with national strategic planning being implemented to ensure that this area becomes a *"vibrant, Inclusive, well-connected, liveable place"* which is also climate resilient and supports a range of uses ([Glasgow City Council, 2020](#)). **Work Package 1** (WP1) of the GALLANT project aims to address the flood risk which is often associated with tidal changes, sea level rise, and increased water due to severe weather events due to climate and environmental challenges. The overall objective of WP 1 is to transform land use along the river corridor while also identifying sites which could be adapted for urban corridor parks and for flood water storage. Additionally, the research team will aim to improve the land use along the river, for both animals and local communities.

### **Work Package 2- Halt Biodiversity Loss**

It is well documented that global biodiversity is in unprecedented decline. Recent research has found that nationally, Scotland's biodiversity has also experienced significant reductions, with recent figures suggesting that Scotland ranks in the lowest 15% of countries in terms of the intactness of its biodiversity ([Nature Scot, 2023](#)). The "direct drivers" of this are known to be the change in land and sea use, the extraction of resources, pollution, invasive and alien species and climatic changes (Ibid). However, there are also "indirect drivers", such as societal behaviours and values which are known to have led to Scotland exceeding its share of planetary boundaries (Ibid). **Work Package 2** (WP2) aims to halt biodiversity loss in greater Glasgow by restoring and connecting habitat patches, an additional aim is to have citizens play a role in helping researchers map important bird, mammal and pollinating species. This will ultimately lead to the adoption of new management practices in

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greenspaces to increase connectivity between habitats across the greater Glasgow area ([University of Glasgow, 2022](#)).

### **Work Package 3- Vacant and Derelict Land**

As defined by the Scottish Government, vacant land is “land as an appropriate site for development, having either previous development or preparatory work in anticipation for future developments ([Scot Gov. Nd](#)). Derelict land, as defined by the Scottish Government, is land which has been damaged by development so that it cannot be used purposefully without the appropriate remedial work (Ibid). According to figures published in 2022, there are approximately 848 hectares of vacant and derelict land across the greater Glasgow region, equivalent to 45 full-sized football pitches. The Scottish Government have suggested that these sites have the potential to be turned into assets with the appropriate remediation work, providing benefits to local communities. Benefits include safe green space, which can be utilised for health and well-being, community growing facilities, affordable low-carbon social housing, renewable development, and business generation (Scot Gov, 2023). **Work Package 3** (WP3)- will endeavour to trial new ways to regenerate vacant and derelict land through innovative technology which aims to mineralise greenhouse gases and trap organic pollutants into building materials for the future. While aligning with strategic national policy objectives, ultimately remediating soil and returning these sites to communities for community benefits discussed above ([University of Glasgow, 2022](#)).

### **Work Package 4- Active travel and Inclusive mobility**

Active travel, as defined by Glasgow City Council (GSC), is known to mean the adoption of moving around from place to place, which requires more concerted effort from the individual ([GSC, 2022](#)). Active travel usually involves one or more of the listed exercises: walking, cycling, wheeling and skating. It is typically adopted for everyday activities such as journeys to school, work, and shopping, as well as for recreation, health, and well-being. Adopting more sustainable forms of mobility and transport will be essential for Scotland's net-zero by 2030 commitments. Further, a reduction in the use of carbon-intensive modes of transportation will support healthier, cleaner and sustainable cities, contribute to the reduction in social injustices associated with transport networks, make a positive impact on economic success and help create communities where we can all thrive regardless of income or mobility challenges. **Work Package 4** (WP4) aims to enhance connectivity across the city centre of Glasgow and the greater Glasgow region. This less carbon-intensive connectivity will be essential to support efforts that aim to halt the loss of biodiversity and ultimately create a cleaner, healthier and sustainable city that supports and welcomes inclusive mobility. Researchers in WP4 will work directly with local communities to increase active travel, including

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cycling, wheeling, walking and skating, to reduce car journeys, improve air quality and reduce carbon dioxide emissions ([University of Glasgow, 2022](#)).

### **Work Package 5- Sustainable Energy**

Adopting more sustainable forms of energy generation, which emit little to no greenhouse gases once construction and installation have been completed, will be essential for our NetZero by 2030 commitments. Now more than ever, we are more aware of the damaging effects our current dependence on fossil fuels may hold on our collective future. Fossil fuels, which are substances such as coal, natural gas and oil, are not only harmful to our planet, but when burned for electricity and other products for human consumption, they are also known to be unsustainable as a finite resource ([United Nations, Nd](#)). Sustainable energy includes any form of energy generation that does not harm the environment once completed or increase climate change. Examples of sustainable energy include wind, solar, and water (hydropower), all of which are considered inexhaustible and widely available to most communities; the best option for communities will typically vary and be dependent on the needs of local people and the geographical location of communities, taking into consideration topography etc. **Work Package 5** (WP5) of the GALLANT project will aim to develop low-carbon energy solutions at the community scale to empower local communities as active energy citizens to co-create clean energy demand ([University of Glasgow, 2022](#)).

### **Methodology**

This study aimed to unearth the barriers which impact students from underrepresented backgrounds in accessing higher education and climate science. Due to the participatory nature of the research project, a focus group was adopted at the end of the fifteen-week program to gather the thoughts, opinions and feedback on the work participants undertook. *Focus groups* are a qualitative data collection approach bridging scientific research and local knowledge ([Cornwall & Jewkes, 1995](#)). This method was favoured as it is known to be a less formal interview method which offers a more in-depth, in-group discussion, allowing participants to build on others' ideas, also known as "piggybacking" responses ([Leung, 2009](#)). The focus group was semi-structured and facilitated by a moderator from the University of Glasgow. However, the moderator did not plan or deliver the workshops included in the program, instead choosing to observe the work being undertaken with members of the target group, the overall objective of this approach being to attempt to remove affiliation with the delivery of the program and improve the impartiality of the

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data (Ibid). Further, graphic facilitation was also adopted to improve the validity of the data gathered from the focus group discussion.

Graphic facilitation is known to be a robust, creative communication tool which is known to improve the integrity of data, mitigate barriers between the researcher and the researched, promote ownership of data and support the co-creation of knowledge which is of particular interest to individuals from certain cultures ([Wright, et al 2023](#)). Broadly speaking, graphic facilitation visually captures and records conversations in real time by combining drawings, text and colour (Ibid). This process typically records a non-linear visual of complex ideas, concepts and potentially even moods; it synthesises the essence of mental models and group discussion ([Dean-Coffey, 2013](#)). The benefits of adopting this approach to data gathering for participants, particularly groups from underrepresented backgrounds, is that those with low levels of confidence feel more comfortable in sharing their ideas and expressions through the adoption of a more open-ended framework (Packard, 2008); further the inclusion of visual representations of mental models and discussions is known to support participants with varying levels of education and language and literacy skills, images speak across different languages and ultimately are known to facilitate dialogue and understanding when English is an additional language ([Sandholt, et al. 2022](#)). The use of multiple data sources supported triangulation and a more comprehensive understanding of the work which was undertaken with our community-based partners at Glasgow Science Centre and the validity of the data that was gathered. The data was then coded looking at both semantic and latent meanings, before undergoing an inductive thematic analysis and interpretation of the key themes. The finished graphic recording can be found in figure 1.1.

*Figure 1.1*





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- The Scottish Government invests £51 million annually to support widening participation for students who come face multiple disadvantages.
  - Widening participation can assess students on a case-case to case basis, offering ESOL courses where appropriate to support students who face challenges with English as an additional language.
  - However, structural barriers remain that make accessing higher education increasingly challenging for groups facing intersecting disadvantages.
  - With the ongoing conflicts across the world, for example the ongoing military action in Ukraine, increasing numbers of refugees and asylum seekers continue to seek refuge in the United Kingdom, roughly 174,000 from Ukraine alone in 2023.
  - Those seeking refuge hold varying levels of qualifications, with some already possessing bachelors and masters degrees. Visa restrictions and the recognition of qualifications and what that entails in terms of costs and guidelines means that those seeking refuge find it challenging to meaningfully use the qualifications they hold.
  - Third sector organisations who support ethnically and culturally diverse groups, claim that there remain steep challenges in accessing higher education. With some groups not requiring ESOL courses, however, this tends to be the go-to option for widening participation programs whose work aims to support these groups.
  - The Scottish Government currently has a multi-strand approach to widening participation initiatives. Work is being undertaken intended to benefit everyone, however, there must be more engagement with local equality strands to ensure certain groups don't fall between the cracks and intersectional thinking is adopted ([Christoffersen, 2022](#)).

### **Micro and Meso-level challenges in accessing higher education: Social and Cultural identity**

- Recent research has highlighted that application rates tend to be impacted by intersecting disadvantages. As disadvantages intersect with complexities such as race, gender, ethnicity and marital status they manifest and create micro- level challenges which makes the transition into higher education complex ([Hoskins & Ilie, 2017](#)).
- There were indicators that the GALLANT Climate Innovators club began to change social identity which is known to be crucial in shaping attitudes and beliefs towards higher education. *Social identity* can impact the professional pathways individuals choose and the university which they seek to attend. With those from working class backgrounds typically applying for less prestigious

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universities and those from middle-class families applying for Russell group institutions ([Hoskins & Ilie, 2017](#)).

- This was evidenced through a selection of participants expressing their desire to attend university. With one participant stating “ *he (son) is making subject choices at school for exams and his choices have changed since completing the program*”. The program enhanced *cultural capital* and participants began to see higher education as a choice in their professional pathways.
- However, concerns were raised around the cost of returning to higher education, working around parenting commitments and the financial burden which comes with having larger families and the cost of childcare. It should be noted that these are areas which are discussed by the [Scottish Wider Access Program](#). However, many groups were not aware of this program prior to attending the program being undertaken with our community-based partners at Glasgow Science Centre.

**Can the reconfiguration of rigorous climate science and the adoption of mission oriented messaging support conceptualisations of climate science making it more accessible and actionable ?**

- Mission-oriented innovation aims to mobilise and align diverse stakeholders around shared challenges, recent research has highlighted the importance of public participation for socio-economic transformations and attaining missions which seek to solve wicked challenges ([Wiarda, et al. 2023](#)).
- In contrast to previous mission-oriented innovations which were traditionally technology focused, contemporary mission-oriented programs strategically aim to align diverse stakeholders, while also adopting a systems approach for transformative change (Ibid); moving beyond research silos and adopting a solutions based outcome-oriented innovation (ibid).
- Mission-oriented messaging aims to address the knowledge-action gap which is well documented in climate research (Sandholt, 2023).

**Knowledge acquisition and stages of cognitive development**

- In learning theory it is understood that as individuals cognitively develop and construct new knowledge, cognitive development is constructed through assimilation and accommodation

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building upon the knowledge we already have and separating them into distinct schemas ([Lefa, 2014](#)).

- What was evident from the data gathered was participants began to assimilate and relate the information that was presented into existing schemas and real-life experiences. This was evidenced through statements such as:

*In terms of energy- WP5- “ I changed all of the light bulbs in my house to LED lights because they use less energy” - **Participant Govan Help.***

*In terms of active travel- WP4- “ I began to track my steps using my phone, as [active travel] is good for my mental and physical well-being” (emphasis added). **Participant-Community Renewal.***

- The information that was presented was added to already established cognitive structures, however, these cognitive structures were extended to assimilate that which was already known.
- The workshops were also sporadically attended by early-career researchers (ECR) from the GALLANT project. This approach aimed to support social constructivism with participants learning from and with the assistance of a more knowledgeable other ([Shabani, 2016](#)). What was evident from the data was the workshops attended by ECR's showed higher levels of knowledge acquisition.
- This attendance allowed for the implementation of discussion in the learning environment and participants began to generalise and transfer their knowledge, building a deeper understanding of what they were learning ([Palinscar, 1998](#)).

**Action: making interconnections visible**

- As previously mentioned, mission-oriented messaging aims to move beyond research silos and adopt a systems approach to research and innovation which engages diverse stakeholders; missions should aim to create scientifically informed and democratically empowered citizens ([Sandholt, et al. 2022](#)).
- Research which adopts this approach should aim to effectively bridge the gap between knowledge generation and implementation ([Adshead, et al, 2023](#)).
- What was evident from the data gathered was participants expressed a desire to change certain behaviours. Particularly when it related to actions which they felt within their control, for example changing lights, reducing use of appliances at home, walking more and tracking steps.

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In this sense the information that was provided was balanced and matched societal needs; it began to provide new directionality for diverse stakeholders.

- What is essential for mission-oriented research and innovation is that there is coordination between research silos. While this remains challenging for research institutions due to the structure of curriculums and distinct nature of research schools. It remains possible for transdisciplinary research projects such as the climate innovators club.
- Moving forward and as we enter phase 2, the project could be strengthened by making inter-connections between the work packages more visible. The participants were able to identify individual actions which they could relate to real life experience or assimilate new knowledge.
- However, the participants couldn't make the connections between the work packages or define mitigation strategies which moved beyond surface learning. A deeper level of understanding would encourage participants to think critically around certain topics, tie information to other subjects, and aim to understand the meaning behind the material. An example could be the links between energy and flood risk, what are the larger changes individuals can make to slow down climate changes. Energy use is linked to much more than household energy consumption.
- Also links between vacant and derelict land and biodiversity loss. Active travel and energy consumption. Making the interconnections visible will support the abstraction of meaning and support conceptualisations of the challenges we face ([Marton & Saljo, 1997](#)).

***Next steps identified by community-based partners at Glasgow Science Centre for Phase 2:***

- Enhanced collaboration and regular meetings with the GALLANT team and early career researchers.
- Consultation sessions after initial meetings with cohorts to establish language barriers and to then tailor content to ensure that it matches the needs of the participants.
- Increased documentation throughout the project to track the work being undertaken.
- Early university visits to build on cultural capital.
- Engaging with adult learners and offering participants the opportunity to engage more frequently with the GALLANT team.
- Additional staff from third sector organisations to support participants.
- Increased language support for participants

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- Community exhibit displayed in the science centre which showcases the learning journey.

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