Climate Smart: Geography, place and climate change adaptation education

Abstract

Geographical education provides a unique space for supporting climate literacy and action. In this paper we present a novel place-based online educational resource platform - Climate Smart – which seeks to expand the capacity of young people to engage in one dimension of climate action, adaptation planning. The Climate Smart platform comprises a set of six online workshops containing videos and quizzes and ends with a serious game – iAdapt. We outline the drivers and process behind the development of the platform, outlining the results of prototype testing and setting out how the platform is evolving. Positive results have been revealed through evaluative analysis to date and novel extensions of the platform are ongoing, although challenges remain regarding the longer-term sustainability of the platform.

Authors

Anna R. Davies*: Geography, School of Natural Sciences, Trinity College Dublin, Ireland. Email: daviesa@tcd.ie

Stephan Hügel: Geography, School of Natural Sciences, Trinity College Dublin, Ireland. Email: shugel@tcd.ie

Alison Norman: Environmental Education Unit, An Taisce, Ireland. Email: anorman@eeu.antaisce.org

Grainne Ryan: Environmental Education Unit, An Taisce, Ireland. Email: gryan@eeu.antaisce.org

*Corresponding author

Climate Smart: Geography, place and climate change adaptation education

Introduction

Geography is uniquely positioned to support the acquisition of essential capabilities for addressing climate change. Students of geography have long been encouraged to think about the world as comprising of systems and how they change and interact over time and why (Aspinall, 2013). As a result, geography teaching and learning should be at the core of efforts to develop climate change literacy and action (Scoffham, 2013). Certainly, understanding the co-evolution of earth and society is a pre-requisite for robust climate change governance. Geography provides a connecting space in the curriculum to bring together creative thinking from the arts, as well as critical insights from the toolkits of social science and humanities and important methods and techniques from natural sciences (Bracken & Oughton, 2009). Focusing, as it does, on matters of space, place, scale and nature-society interactions, students develop not only skills and knowledge essential for tracing changes in climates, but also learn how those changes create differential impacts for people in diverse places over time. It allows for a 'big picture' view of the world, whilst also providing detailed exemplars of process and practices in places that provide the building blocks for problem solving complex issues such as climate change (Murphy, 2020; Smith & Pike, 2023). Geography teaching applies abstract concepts, theories and methods in real world settings, expanding world views whilst also allowing students to bring their lived experiences into the classroom.

However, while the benefits of a geographical education for addressing the challenges of climate changed futures might be clear to those within the discipline, this is not necessarily the case within wider society. In Ireland, for example, recent actions by the Department of Education have removed requirements for mandatory geographical education at junior certificate level (students aged 12-15). Meanwhile, they are developing a new subject for the leaving certificate, a two-year national curriculum taken by 16-18 year olds, focused on climate action and sustainability that is due to be piloted in 2024. The shifting landscape of geographical education in Ireland under conditions of climate change was one key motivation for developing the Climate Smart educational resource platform – the focus of this paper – that seeks to expand the adaptive capacity of young people in relation to climate change. The second was the lack of resources for climate change adaptation education – defined by the Intergovernmental Panel on Climate Change (IPCC, 2018: 542) as "the process of adjustment to actual or expected climate and its effects, in order to moderate harm or exploit beneficial opportunities", in favour of mitigation which focuses on human interventions to reduce emissions or enhance the sinks of greenhouse gases.

This paper first outlines the drivers, content and early stage impacts of a place-based online educational resource platform – Climate Smart – focused on expanding the capacity and capabilities of young people to engage in climate change adaptation planning in Dublin. It then outlines the challenges and possibilities for translating this resource into other settings, arguing that localising resources provides for optimal learning outcomes. It concludes by setting out potential pathways for developing an international network of Climate Smart resources.

Climate Smart Development

The need for adaptation education

The need for adaptation to climate change has been articulated across many reports of the IPCC, stressing that adaptation action is best implemented at the local and national level, in tandem with coordinated global governance to effectively act on transboundary risks. Global adaptation governance surfaced as a public goal in 2021 when the United Nations Framework Convention on Climate Change (UNFCCC) launched the Global Goal on Adaptation at COP 26 (Persson, 2019). Research suggests that higher levels of education lead to greater adaptive capacity and resilience to climate change thereby reducing damages from its consequences (O'Neill et al., 2020). Yet in comparison to climate mitigation, there is minimal focus on adaptation in the public realm (Hügel & Davies, 2020). At the time of writing, Ireland is awaiting a revised National Adaptation Framework as called for by the Climate Change Advisory Council in 2022 and local climate action plans (including both mitigation and adaptation) are due to be completed by March 2024, but there are no educational resources supporting young people's engagement with climate change adaptation planning.

Co-design of Climate Smart

Dublin, a coastal city, is already experiencing negative effects from climate change through increasing intensity and frequency of adverse weather events and particularly flooding and sea level rise. These negative impacts are predicted to expand in the future, with the Dublin Region Climate Change Action Plan (2019-2024) detailing that the average sea level of Dublin Bay is already rising by twice the global average rate over the last 20 years. Governance architectures for climate action have emerged such as the Dublin Climate Action Regional Office, but actions are limited with respect to education and adaptation. Indeed, only one educational action point is proposed to "[d]evelop and implement an education programme to tackle climate issues related to the water sector" (Dublin City Council, 2020, p. 105) by 2027. Beyond this, education is mentioned only generically e.g. to "Develop education and awareness initiatives for the public, schools, NGOs and other agencies engaged in driving the climate change agenda" (Dublin City Council, 2020, p. 24).

With the goal of increasing effective youth engagement with, and understanding of, climate change adaptation planning at the local level, the Climate Smart project emerged from a smart city initiative - Smart Dublin Docklands - seeking to support more connected communities within a specific area of Dublin inner city experiencing multiple stresses from increased flood risk (fluvial, pluvial and coastal) and gentrification processes (Davies & Hügel, 2020).

Initially, face-to-face discussions about matters of climate change, flood risk and climate justice were held with Transition Year (an optional year between the junior and senior secondary educational cycles in Ireland) students (aged 15-16) who attended the community college located in the area. The college holds a DEIS (Delivering Equality of Opportunity in School) designation, as it is in an area of socio-economic disadvantage. A range of potential mechanisms to learn about climate change adaptation were explored with the students (from standard textbook based learning through to digital role play exercises) which revealed a desire for more place-based learning and a positive opinion on the use of technology in education and climate adaptation. However, due to the Covid-19 pandemic restrictions in 2020, the project had to pivot away from a face-to-face model and the research team initiated a process of co-designing an online Transition Year module suitable for 15-16 year olds (Hügel and Davies, 2022). The co-design process included workshops with students, teachers, climate scientists, policy makers and shapers and educational games specialists and culminated in a suite of seven digital workshops, including videos, quizzes, suggestions for hands on activities and an online serious game (Davies & Hügel, 2021).

Climate Smart resources

The entire Climate Smart platform module is designed to be flexible and can be accessed at: https://climatesmart.ie. Its resources can be used in multiple ways: Students can work independently and individually through the modules at their own pace; students can work together in pairs or small groups through materials; or teachers can show the videos to the whole class and then allow students to work through the other materials themselves or as a group. The Climate Smart module contains seven workshops, six comprising short videos and assessment via multiple choice questions. These workshops lead students through the fundamentals of climate change (workshop 1), and provide important parameters of flooding processes, monitoring mechanisms and impacts (workshops 2 - 4) as well as providing details of various adaptation options (workshops 5 - 6). Each workshop is designed to fit within a standard 40-minute class time slot but can be expanded by having classroom discussions on key points or by undertaking additional hands-on activities also detailed in the module materials (such as preparing a flood awareness poster for the school). The final workshop, workshop 7, revolves around the digital map-based role-playing game set in the year 2045 – iAdapt. iAdapt is a serious game; that is one designed for a 'serious' purpose rather than simply for entertainment: in the case of Climate Smart this focus is climate change adaptation. iAdapt is the final component of the Climate Smart learning experience. The game allows the students to use their learning from the previous six workshops in an interactive, engaging manner to adapt Dublin city. All resources are free to use after registration and the game is open access.

iAdapt requires players to first adopt the persona of the mayor of Dublin City. They get an annual budget of €10 million, and their goal is to climate proof the city. They do this through a plan-consult-revise-adopt process in each round. In the first phase (see Figure 1) players examine and select their chosen interventions which are categorised under four headings: green-blue (e.g. raingardens, tree planting); grey (e.g. concrete sea walls); mixed (e.g. green-grey interventions such as porous pavements) and policy interventions (such as community adaptation planning or citizens' assemblies on climate adaptation).
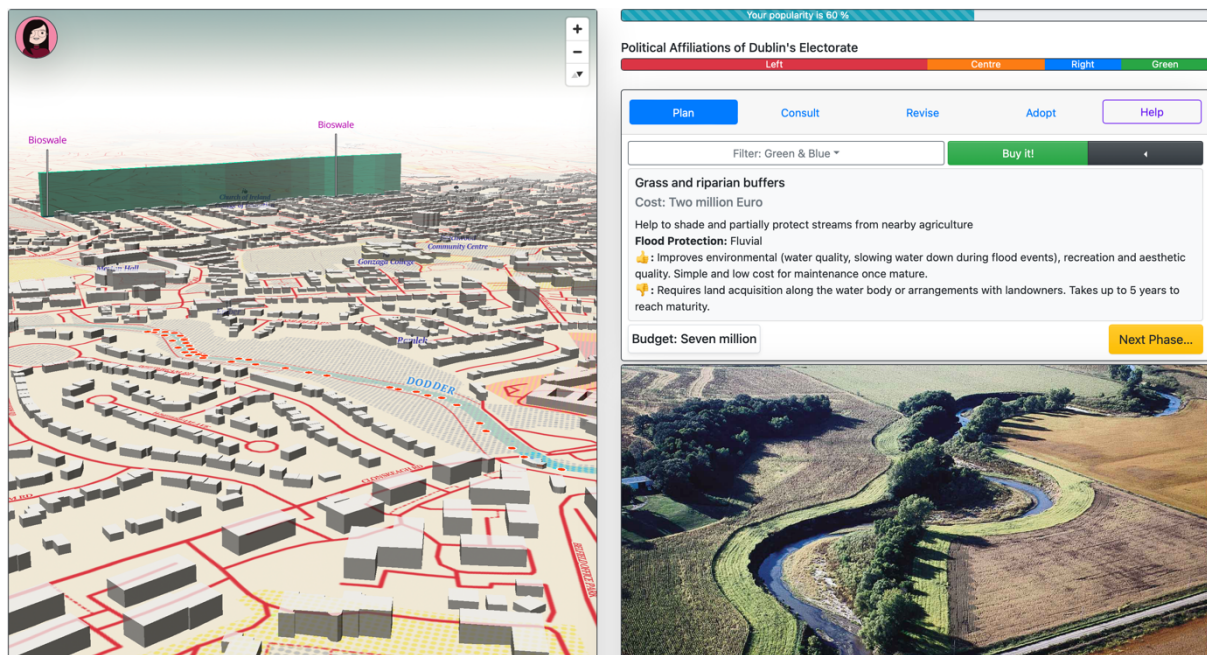

Figure 1: Consult phase, showing information on a green and blue intervention.

Under the consult phase players get information on the advantages and disadvantages of each intervention, feedback from social, economic and environmental actors on their selections and are subject to the effect of public opinion on measures taken through a 'popularity' monitor. If their popularity drops below 20%, they are removed from office and the game ends early, and an unpopular plan can trigger protests (see Figure 2). In the revise phase players can select new interventions and deselect others as they wish. Once the adopt button has been pressed a randomised flood event occurs (based on actual flood prediction data for 2050) and feedback is provided on the success of their adaptation plan. There are five rounds to 2050 which all involve these planning, consultation, revision and adoption phases. Once they have finished all five rounds to 2050, players get information detailing their investments and protection levels and a score is calculated based on the success of their adaptation strategy. Students can see how their score compares across all games played, and to other students in their class.
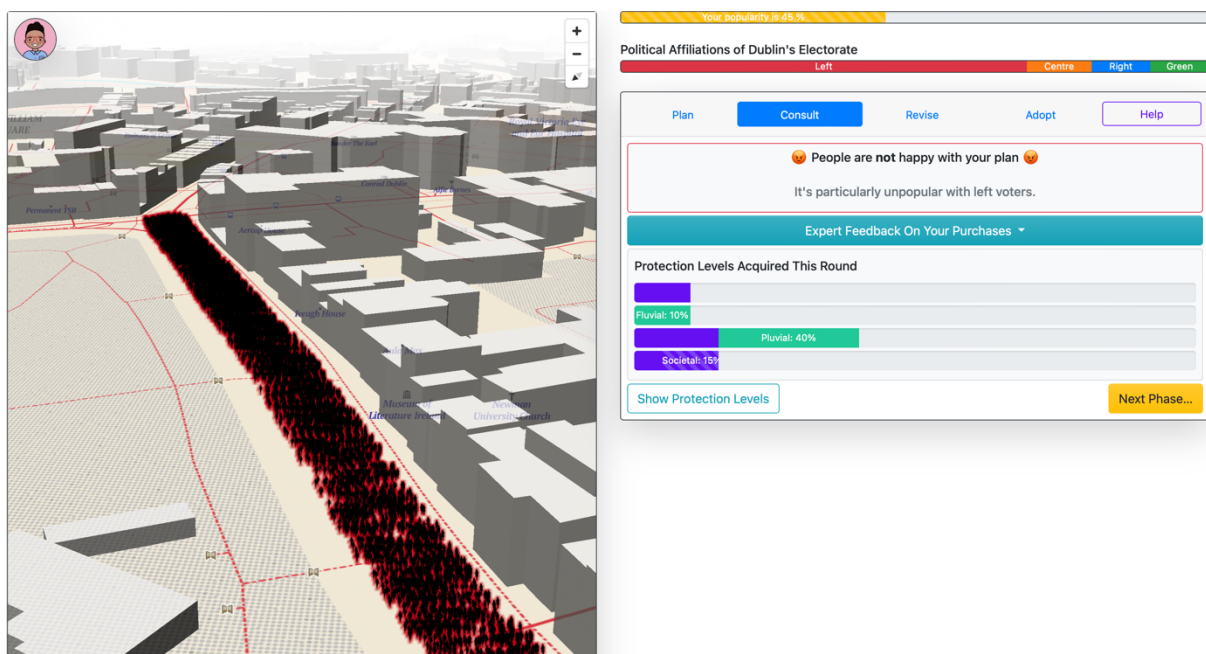

Figure 2: protest triggered by an unpopular plan. Current protection levels are also shown.

Evaluating Climate Smart

From a technical perspective, the platform has both teacher and student interfaces. Once registered, teachers can download the Climate Smart Handbook, monitor student progress, and manage workshop access. The handbook guides teachers on using the platform, troubleshooting, and contains additional activities for further hands-on exploration and action.

A pre- and post-module survey has been integrated into the module collecting ongoing data from students relating to engagement with the module and its impacts. Full discussion of evaluation processes across the co-design, prototyping and testing is outlined elsewhere (Davies and Hügel, 2020; Hügel and Davies, 2022; 2024), with the tables below providing details of the questions asked of students. Students entered their responses to each question on a Likert scale from strongly agree to strongly disagree (Table 1). In the prototype testing phase 374 students were given the survey before the first workshop and 239 of those completed the questionnaire following the final

workshop. The responses to these questions were then mapped onto specific capabilities for adaptive capacity in climate change adaptation: knowledge and learning; agency and empowerment; social networks and support; and resource access and management (Figures 3-6).

Question	Content	Adaptive capability element
1	I think about climate change	Knowledge & learning
2	I think the world's climate is changing	Knowledge & learning
3	I'm worried about the effects of climate change on my community	Agency & empowerment
4	I think it is too late to do anything about climate change	Agency & empowerment
5	I know about the history of flooding in my community	Resource access & management
6	I know what the government and local authority are doing to help my community to cope with climate change	Social networks & support
7	I understand the difference between climate change mitigation and climate change adaptation	Knowledge & learning
8	I think technology is the most important tool we have to help us to adapt to climate change	Knowledge & learning
9	I think interactive maps are a useful tool for talking about and demonstrating the effects of climate change	Social networks & support
10	Games are a good way to help us to imagine the effects of climate change	Social networks & support
11	Imagining what our lives will be like in the future is a good way to discuss adaptation to climate change	Social networks & support
12	I think that changing my own behaviour can help to limit the effects of climate change	Agency & empowerment

Table 1. Student questionnaire completed before and after engagement with the Climate Smart module.

Knowledge and learning capabilities are key for better comprehension of the causes and impacts of climate change, as well as understanding adaptation options. Questionnaire responses indicate a significant change in respondents' understanding in relation to the question "I understand the difference between climate change mitigation and climate change adaptation". Other questions relating to this capability reveal that while the changes are not significant, following the workshops and game, students thought about climate change more often overall (Figure 3).
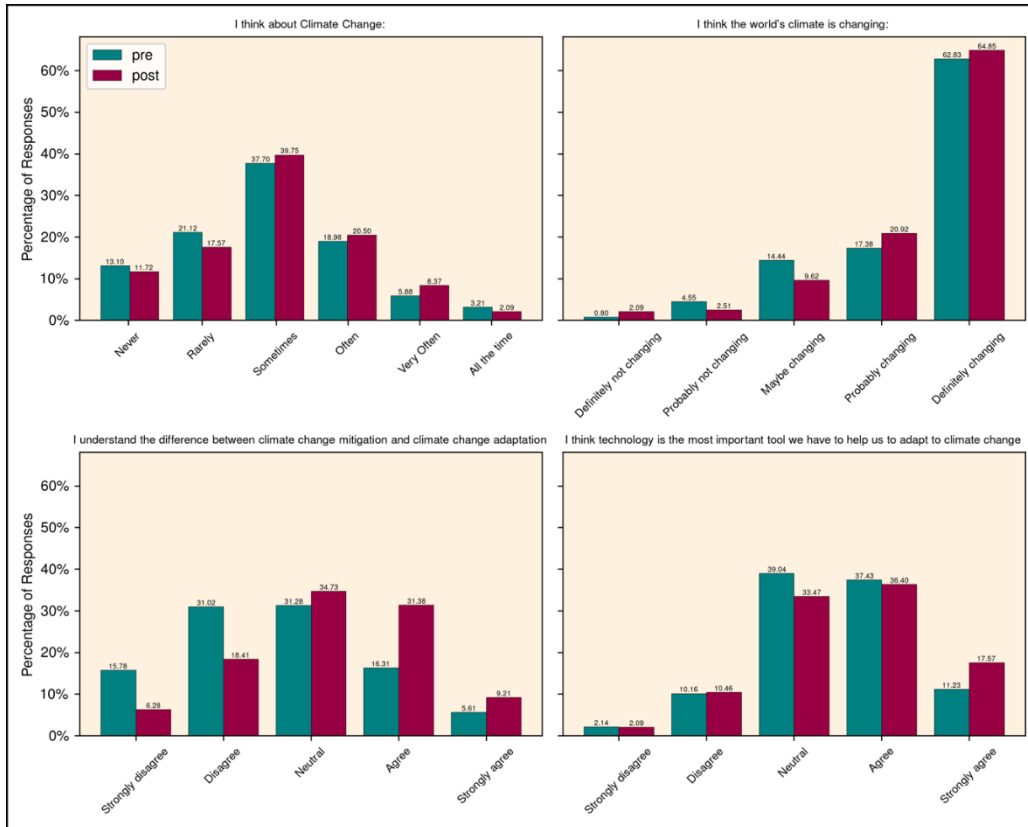
Figure 3: pre-workshop and post-game responses relating to "knowledge and learning".

Creating a greater sense of personal *agency and empowerment* is seen as key to building adaptive capabilities. These capabilities are related to people having a degree of input to adaptive processes and can contribute to decisions about how to respond to climate changes. After following the Climate Smart module there was a significant change in respondents' understanding in relation to the question "I think it's too late to do anything about climate change" (Figure 4).
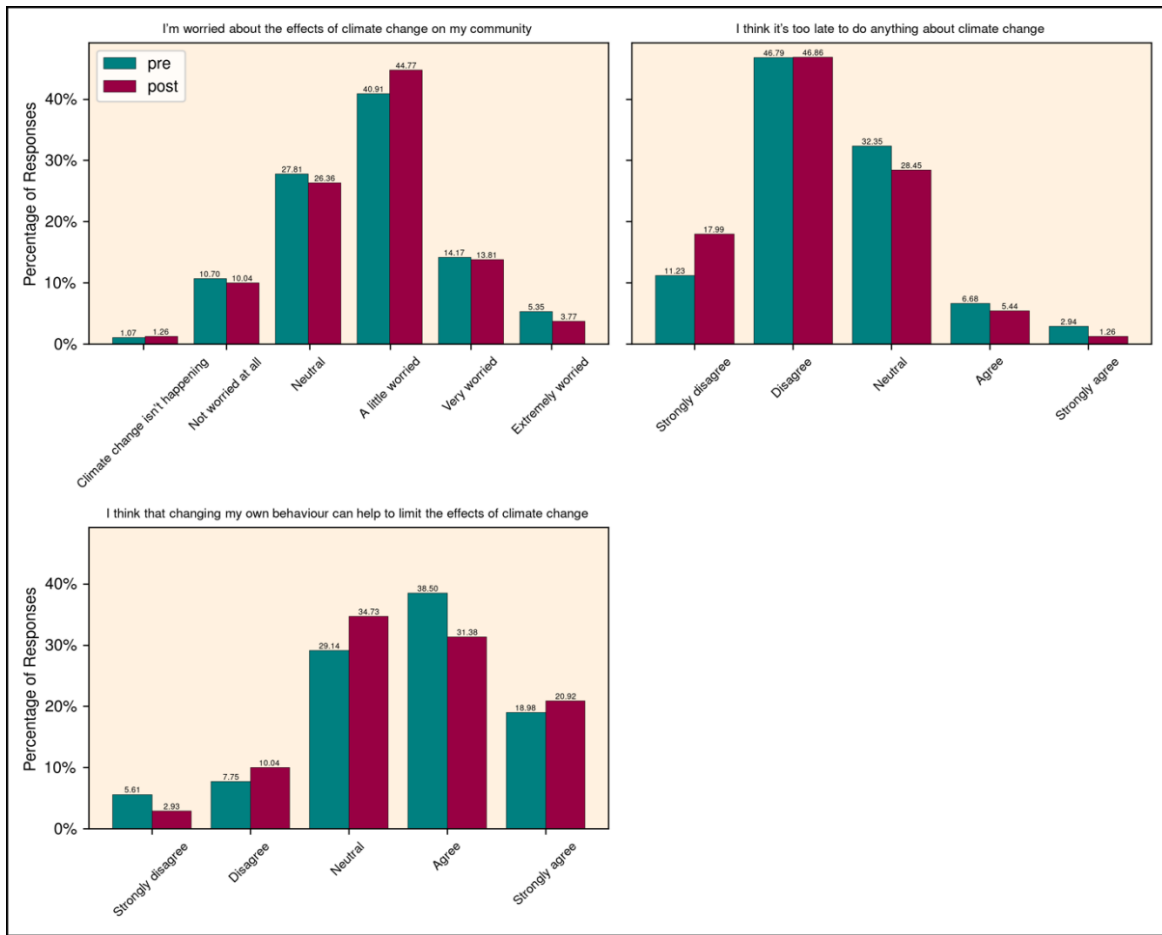
Figure 4: pre-workshop and post-game responses relating to "agency and empowerment".

Social networks and support systems are important for building and maintaining adaptive capacity by providing new sources of information and resources. Such supports are important under conditions of complexity and uncertainty and having a range of social connections is significant when seeking to build collective action on climate change. Results show a significant change in respondents' understanding in relation to the question "Games are a good way to help us to imagine the effects of climate change" (see Figure 5). While changes in relation to questions of government action and imagining climate-changed futures are positive, they do not reach the significance threshold.
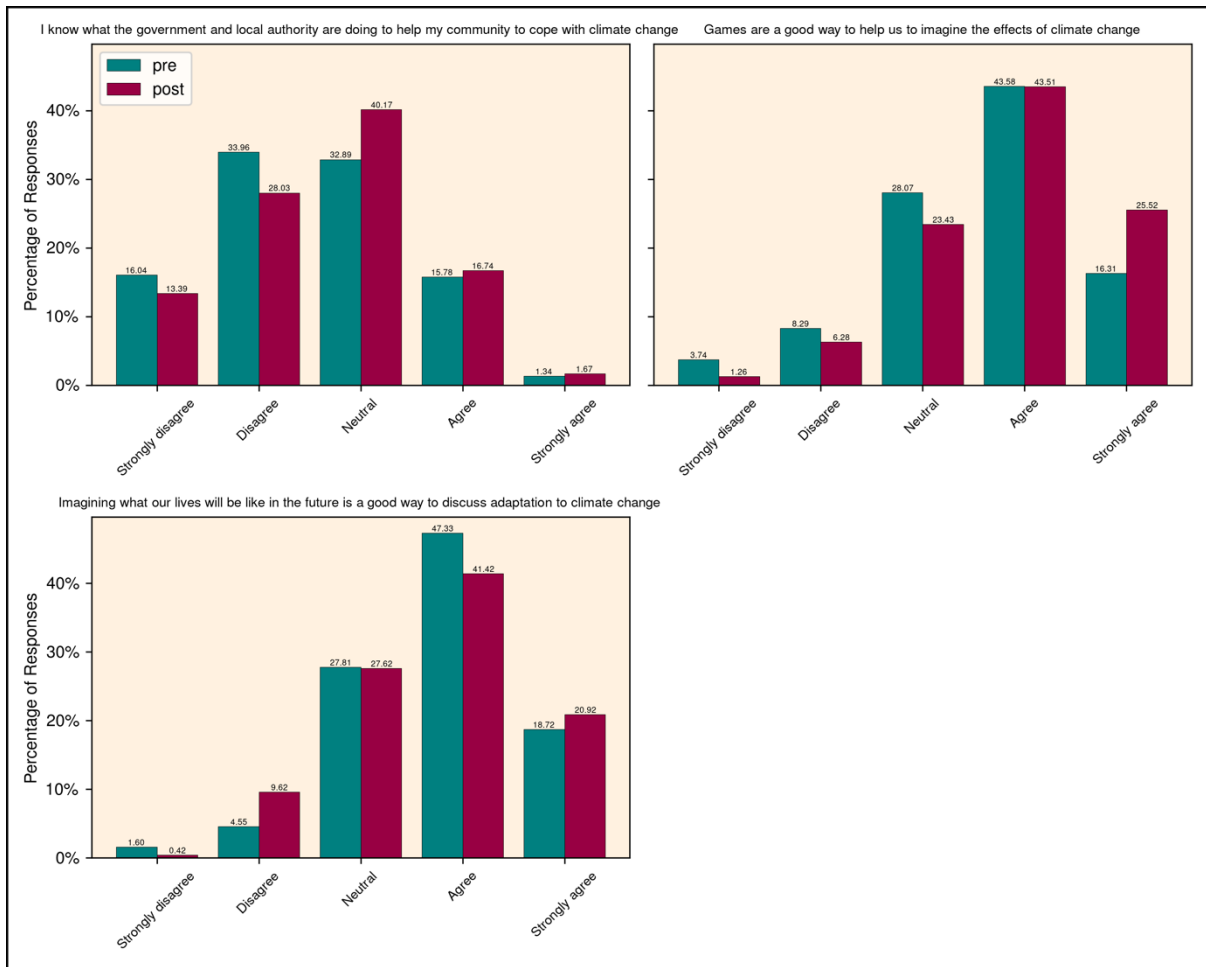
Figure 5: pre-workshop and post-game responses relating to "Social networks and support".

Building adaptive capabilities in relation to *resource access and management* refers to the ways in which people access and manage natural resources in an appropriate manner. Such capabilities are addressed in the Climate Smart platform insofar as this relates to knowledge, skills and understandings of water and flood management, land use planning, and nature-based adaptation solutions. The questionnaire results reveal an overall positive change in students' self-assessment of their knowledge of flooding in their community although not at a significant level (Figure 6).
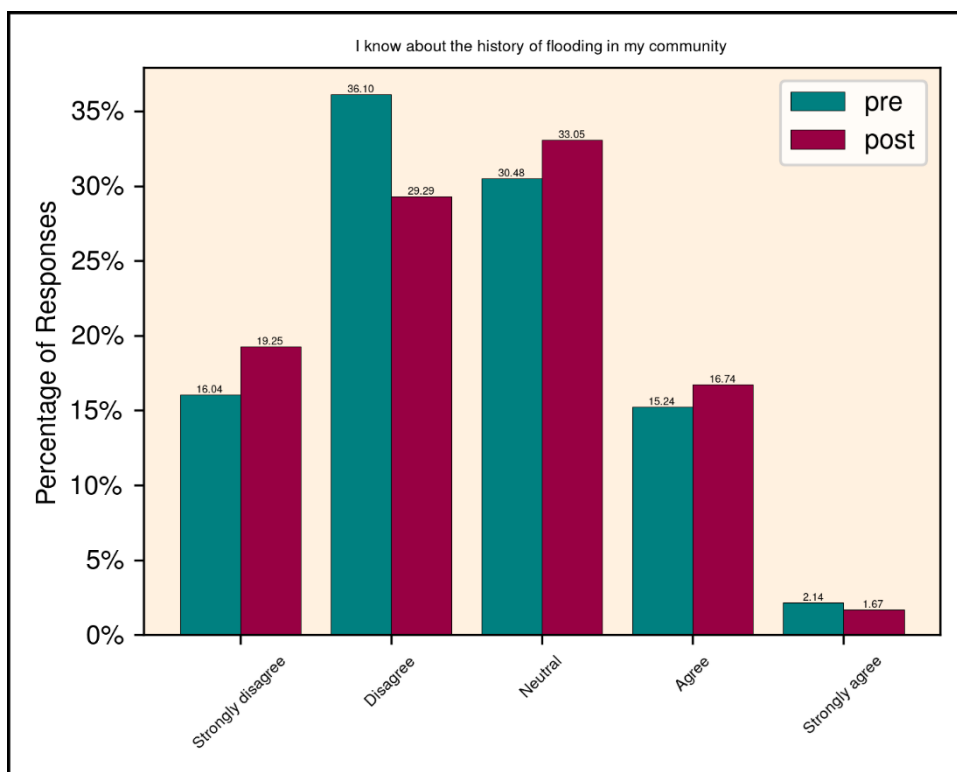
Figure 6: pre-workshop and post-game responses relating to "resource access and management".

Teachers were also interviewed about their experience of running the module and were encouraged to provide feedback. Teachers reported the game as a highlight and motivational tool that encouraged students to progress through the workshops (Hügel and Davies, 2024). By the end of 2023, 50 schools and more than 1500 students had followed the Climate Smart module.

Climate Smart evolution

The initial iteration of the Climate Smart platform described above focused on the place-based effects of climate change in Dublin. The game in particular extensively relies on place-specific features for its efficacy by presenting a familiar representation of the city of Dublin to players and allowing them to make changes that are – broadly – in keeping with existing or proposed future interventions. These place-based features make use of the specific geographies of flooding and flood defence in the city in order to produce a playing environment which complements and deepens the knowledge that students have acquired during the educational workshops which precede it (Khadka et al., 2021).

While these context-specific features are crucial to the module's goals of using place-based resources and are necessary for the game's function as a serious game, they may also serve to limit its effectiveness in other locales. Players outside Dublin may have limited knowledge of the city other than in an abstract sense of being the capital city of Ireland. We are planning to explore this issue further with a cluster of schools in Donegal who found out about Climate Smart independently of our trial in Dublin. Another research and development activity currently underway is replicating Climate Smart Dublin in Cork, Ireland's second largest city located in the south of the country. This will create multiple pathways through the Climate Smart resource platform and has necessitated

extensive engagement with Cork's history, geomorphology, urban development, as well as contemporary debates around climate adaptation in the city, as was conducted for the initial Dublin context. Additionally, modelled coastal, fluvial, and pluvial flood extent data for Cork, supplied by the Office of Public Works, will have to be prepared and converted in order to be available in the game. This involves cleaning, reprojection, and conversion of the data to map tiles, which are downloaded on demand when the game begins.

Conclusion

With promising initial impact data already collected and wider roll out across Ireland underway, we are moving from the design phase into the implementation phase of the project. This is generating three key areas of concern.

The first is the uncertain long-term impact of such resources on student climate adaptation capabilities in the absence of wider system transformation related to climate change. Climate change policy in Ireland has seen a significant rise in activity since the enactment of the Climate Action and Low-Carbon Development Act in 2015, leading to numerous new policies, plans and institutions. In some areas it has been world leading, for example through the delivery of a citizen's assembly on climate change (Department of Taoiseach, 2018). However, implementing climate action plans and delivering on citizens demands has proved challenging with emissions targets not being achieved (EPA, 2023). Such a governance gap undermines public trust in governments commitment to acting on its climate change responsibilities and can affect their willingness to act themselves.

A second potential barrier to the scaling out of educational platforms such as Climate Smart relates to the future evolution of geography as a discipline and related to that, questions about the extent of teacher capabilities to support the roll out of such resources. This is a particularly acute concern in settings – such as Ireland – where Geography as a discipline is being marginalised from mandatory education. Making geography an optional subject means that not all Transition Year students will have the same foundation of knowledge and skills about nature-society interactions that lie at the heart of climate change. Practically, it also means there will be fewer geography teacher positions available nationally and therefore less capacity to teach matters related to climate change. The Climate Smart resource platform is self-contained and does not demand specific knowledge and skills of teachers, beyond navigating and releasing classes in the online dashboard for students to engage with. Nonetheless, geography teachers remain best placed to optimise the impact of its resources without needing extensive continuing professional development. The removal of geography as a core subject in Ireland risks impoverishing students' futures at precisely the time when they need skills and knowledge to navigate the complex challenges that lie ahead.

The third area of concern relates to the challenges of translating a research project output into an accessible, yet sustainable, mainstream educational resource. Adopting a collaborative co-design approach for Climate Smart has been demonstrated to have positive impacts on students' capabilities for adaptive capacity, at least in the short-term. Any new developments will require significant additional resources to replicate the co-design process established in Climate Smart and locations beyond Ireland may be facing different challenges from climate change such as drought, food shortages, or the shifting reach of vector-borne diseases (Poděbradská, 2020). Even maintaining the existing platform needs ongoing investment.

Within Europe there is an embryonic network of climate change educators, the Education for Climate Coalition, which is a flagship initiative of the European Education Area seeking to create a participatory community to support teaching and learning. As Commissioner Mariya Gabriel says:

> *"'To make a difference' – this is what the #EducationForClimate Coalition is all about. To make a difference in your school, in your neighbourhood, in the very region you live and to contribute actively to the green transition our societies go through."*

Our research suggests that while Geography as a discipline, including its researchers, teachers and students, is perfectly positioned to lead on this climate action focused agenda, this does not yet seem to be acknowledged by national government, at least in Ireland. Despite the efforts of geography teachers and universities to flag this importance, significant work is still needed in this regard.

References

Aspinall, R., 2013. Geographical perspectives on climate change. In *Geography of climate change* (pp. 1-5). Routledge.

Bracken, L.J. and Oughton, E.A., 2009. Interdisciplinarity within and beyond geography: introduction to special section. *Area*, *41*(4), pp.371-373.

Davies, A.R. and Hügel, S., 2021. Just adapt: Engaging disadvantaged young people in planning for climate adaptation. *Politics and Governance*, *9*(2), pp.100-111.

Department of the Taoiseach. 2018. Third Report and Recommendations of the Citizens' Assembly. How the state can make Ireland a leader in tackling climate change. Department of the Taoiseach: Dublin.

Dublin City Council. (2020). *Dublin City Council Climate Action Plan 2019—2024*. Dublin City Council. https://www.dublincity.ie/sites/default/files/2020-07/2019-dcc-climate-change-action-plan.pdf

EPA. 2023. Greenhouse Gas Emission Inventory 1990 to 2022.

Hügel, S. and Davies, A.R., 2020. Public participation, engagement, and climate change adaptation: A review of the research literature. *Wiley Interdisciplinary Reviews: Climate Change*, *11*(4), p.e645.

Hügel, S. and Davies, A.R., 2022. Playing for keeps: Designing serious games for climate adaptation planning education with young people. *Urban Planning*, *7*(2), pp.306-320.

Hügel, S. and Davies, A.R. 2024. Expanding adaptive capacity: Innovations in education for place-based climate change adaptation planning. Under review *Geoforum*

Intergovernmental Panel on Climate Change (IPCC) 2018: "Annex I: Glossary," In: *Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty*. Cambridge University Press, pp. 541-562. https://doi.org/10.1017/9781009157940.008

Khadka, A., Li, C.J., Stanis, S.W. and Morgan, M., 2021. Unpacking the power of place-based education in climate change communication. *Applied Environmental Education & Communication*, *20*(1), pp.77-91.

Murphy, A.B., 2020. Geography: Why it matters. *The AAG Review*, p.34.

O'Neill, B.C., Jiang, L., Kc, S., Fuchs, R., Pachauri, S., Laidlaw, E.K., Zhang, T., Zhou, W. and Ren, X., 2020. The effect of education on determinants of climate change risks. *Nature Sustainability*, *3*(7), pp.520-528. https://doi.org/ 10.1038/s41893-020-0512-y

Persson, Å., 2019. Global adaptation governance: An emerging but contested domain. *Wiley Interdisciplinary Reviews: Climate Change*, *10*(6), p.e618.

Poděbradská, M., Noel, M., Bathke, D.J., Haigh, T.R. and Hayes, M.J., 2020. Ready for drought? A community resilience role-playing game. *Water*, *12*(9), p.2490. https://doi.org/10.3390/w12092490

Scoffham, S., 2013. *Teaching geography creatively*. Routledge.

Smith, E.R. and Pike, S. eds., 2023. *Encountering Ideas of Place in Education: Scholarship and Practice in Place-based Learning*. Taylor & Francis.