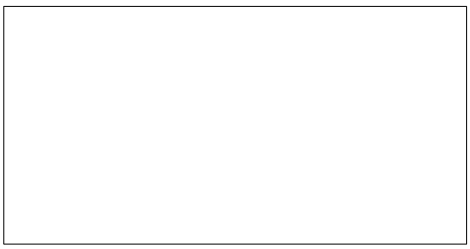

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SPECIAL SECTION ARTICLE

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# Using 360° immersive storytelling to engage communities with flood risk

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**Abstract**

Communities worldwide face escalating flood risks due to climate change, a fact that emphasises the critical role of flood preparedness in community flood resilience. Globally, flood risk is expected to double by 2050. In the United Kingdom, where this study is set, approximately one property in six is already at risk of flooding, with that figure set to increase significantly in coming decades. Children and young people are often overlooked in work on flood resilience and response. Researchers working with flood-affected children have learned from their experiences and supported them in telling their stories and sharing insights about how to best manage flood risk in the future. Here, we advance a research approach that co-created with young people and teachers a suite of educational resources centred on using innovative 360° animation and immersive storytelling approaches. That work has allowed us to bring to life testimonies by children affected by flooding and to advance debates on how empathy can be amplified to widen engagement across a range of audiences and stakeholders. The tools we developed place the user in the centre of the child's flood-impacted world, something that has received relatively little attention. The results provide significant new insights on the use of 360° storytelling approaches that can prompt enhanced, empathic responses that motivate users to want to learn more about flooding, help create a sense of solidarity, and inspire action. We argue that such empathy-driven, action-oriented responses are crucial when developing future flood preparedness plans and enhancing broader community flood resilience.

**KEYWORDS**

children and young people, climate change, community resilience, flood education, flood risk, storytelling

## 1 | INTRODUCTION

This paper seeks to understand how using 360° video can optimise the effects on resilience of telling stories shared by flood-affected children. Our argument is that this approach can prepare children and young people for broader flood education programmes. With reference to one such programme in the United Kingdom, we examine its capacities to enhance flood risk preparedness and support communities to act and improve and inform flood adaptations. The aim of this 'flood stories approach' is to foster empathy by working to enhance understanding of others' perspectives, generate interest in the issues raised, and build greater commitments to act. Three research questions informed that work. Can immersive storytelling create an empathetic response in participants in terms of understanding different perspectives on flood resilience? How effective is the use of real flood testimonies in influencing such engagement? Does the use of 360° video influence engagement and possible action?

Storytelling has been used for thousands of years to educate and inform (Holmes et al., 2016; McEwen & Holmes, 2017). It can make complex issues more relatable and understandable by placing them in a context that people can engage with via deeper, emotional connections. However, the use of storytelling has been underexplored in the context of natural hazards in general (Liguori et al., 2021; Roberts et al.,2022), and flooding in particular. Stories humanise an issue, creating the potential for empathy in ways that facts and statistics may fail to achieve. Indeed, the power of storytelling to generate more engaged responses to climate change has found momentum and is highlighted in the IPCC 6th Report as a tool to engender action (Bloomfield & Manktelow, 2021). That development shows that there is a need to radically rethink the narratives informing environmental change discourses (de Meyer et al., 2021). Placing audiences inside stories about experiencing flooding first-hand can motivate people to want to better understand the causes and effects of flooding (Holmes & McEwen, 2020).

Flooding is one of the deadliest and most costly hazards that communities face around the globe. Moreover, flood risk is increasing because of the impacts of global warming on regional hydroclimates, demographic changes, and economic development in flood-prone areas. These drivers are significantly increasing among the one billion people already living at risk in flood susceptible areas (Hirabayashi et al., 2013). Many of those most exposed to flooding are economically and socially disadvantaged (Rözer & Surminski, 2021) and lack the autonomy to move from more flood-prone areas.

There is consensus that, in many parts of the globe, climate change will result in more significant sea-level rise and cause substantial increases in the frequency of extreme rainfall events that, in turn, will generate increases in flood risk (Wing et al., 2018). Flood risk refers to the likelihood and potential damage that floods can cause to people, property, and the environment. Flood risk management involves identifying such risk and taking actions to reduce it, either by reducing the likelihood of flooding or reducing exposure to it and thus to potential damages. Management thus includes helping people to adapt to flooding using varied forms of placemaking (Malatesta, 2013) to increase protection and the ability to respond to risk and to help recovery (Environment Agency, 2020).

Education is a key agent to address climate change impacts on society (Frantz & Mayer, 2009; Mochizuki & Bryan, 2015) and prepare communities for an uncertain future. Mort et al. (2018a) have highlighted the importance of preparing children and young people for flood risk and flood adaptation as part of one community flood education programme. Such awareness-raising can help minimise the impacts and the range of damage from floods (Mort et al., 2018a). Lloyd Williams et al. (2017) have amplified that assessment and suggest there is a need to connect across generations within communities using action-based learning that ensures flood education is embedded in broader societal flood resilience strategies.

**Key insights**

Using 360° video, we have explored how immersion in children's flood stories can be a powerful tool in a flood education programme, motivating learning, and fostering action among participants and members of wider communities. The approach shows it is possible to create strongly empathetic responses in participants, notably in terms of fostering personal agency and empowerment. It also establishes how technology-enhanced education techniques can engage students experiencing lower attainment outcomes and support their learning.

Our team's research with flood-affected children has clearly shown that children and young people want to be involved as actors in building flood resilience within their communities (Lloyd Williams et al., 2017; Mort et al., 2018a). In addition, Tanner (2010) has identified how children and young people are commonly marginalised and overlooked in climate-related debates and responses to hazards, and often sidelined as victims who need protection from adults. That insight aligns with Valentine's (1997) assertion that children's geographies have often revealed how poorly understood children's social worlds can be. Tanner (2010) has also shown how children's groups have responded to such events using child-centred initiatives that highlight how children are agents of change engaged in preventing disasters and supporting community adaptation to climate change.

Similarly, research with children who experienced Hurricane Katrina has identified that participating in post-event studies helped them show others how to be more prepared for the future in ways that had positive effects on their recovery (Fothergill & Peek, 2015) and emotional well-being (Halstead et al., 2021; Pihkala, 2022; Verlie & Blom, 2022). Trajber et al. (2019) have established that a participatory action research approach with young people led to the co-creation of a set of action and knowledge-based outcomes in their communities, which meant they could shape their community's resilience. Work by Mort et al. (2018a) has clearly demonstrated that even young children see and understand many of the impacts of flooding, are capable of taking action to help their families and communities and state it is their 'right' to be prepared for future flooding. The 'flood manifestos' created by children and young people as part of that work enabled them to communicate their findings to

policymakers. On that basis, the authors argued that flood education should be mandatory for all and that policy changes should ensure children would be involved from a young age in learning about flooding, what to do in flood events, and how to recover from them (Lancaster University & Save the Children, 2015; Lloyd Williams et al., 2017).

Working with flood-affected children after the 2007 severe floods in Hull (UK), Whittle et al. (2011) have used an action-based storyboarding approach to show how flood impacts were wide-ranging and could elicit richly informative children's stories. Likewise, work by Lloyd Williams et al. (2017) with flood-impacted children has established the strength of young people's collective voices in speaking directly to policymakers and practitioners and showed how the power of their stories and perspectives could mobilise stakeholders to action. Events held at the end of their project explored how stakeholder engagement could be linked to the empathy evoked when members of the audience were invited to walk in children's shoes and experience flooding from their points of view. Recent research has also indicated that engagement with personal stories can provide enhanced motivation for audiences to act in terms of climate change (Finnegan, 2023) and flood preparedness more specifically (McEwen & Holmes, 2017).

Using immersive methods and technology to place participants in stories, 360° storytelling has recently emerged as a powerful tool in a range of sectors, including education (Pirker & Dengel, 2021). Digital three-dimensional (3D) environments, or virtual realities (VR), are effective in placing users in a simulated world that feels real (Blascovich & Bailenson, 2011; Yang & Zhang, 2022), bringing them closer to otherwise distant ideas (Markowitz et al., 2018; Trope & Liberman, 2010). Petousi et al. (2022) have identified how artistic representations can be used to make the familiar strange so participants can explore the known by framing it with new perspectives. That approach helps users to develop attachments and experience empathy (Clark, 1997; Yang & Zhang, 2022). Stimulating the imagination also creates highly engaging environments supportive of learning outcomes (Bricken & Byrne, 1993; Liu et al., 2020; Markowitz et al., 2018; Salzman et al., 1999). Work by our team has shown how creative immersive storytelling can successfully engage users with ideas about flood risk (Skinner, 2018; Skinner, 2020) (Figure 1).

Here we present a combination of the two approaches described above, using the power of immersive storytelling via 360° video to amplify real stories by children affected by flooding and to mobilise audiences to action. We developed two bespoke 360° videos, entitled Help Callum and Help Sali, which immerse observers in flood stories shared by two children who have experienced flooding. The videos draw on data gathered during our team's research with children affected by severe winter floods in the United Kingdom in 2013–14 (Mort et al., 2018b). The videos set out to engage audiences by fostering empathic connections with Callum and Sali, and by encouraging them to independently explore and reflect on those stories, especially in relation to the forms of 'help' characters needed at different stages.

**FIGURE 1** Screen shots from Inundation Street, an immersive storytelling 360° video designed to inform and educate communities about personal flood preparedness. Source: Skinner et al., 2019.

In section 2 we develop and detail our methodological approach. Section 3 provides details of our co-creation workshops, and the results derived. Section 4 provides a synthesising discussion before conclusions are drawn in section 5.

## 2 | METHODOLOGY

### 2.1 | Storytelling as a research methodology

Storytelling is a powerful research methodology that offers rich insights into human experiences, motivations, and decision-making processes. While stories often draw upon past experiences, Wilson (2021) has argued that they are "shapeshifters" adapting to the teller, listener, and context with each retelling. This fluidity, Wilson argues, allows stories to function as platforms to test ideas individually and collectively. As such, storytelling can be a tool to reflect and challenge the present, envision a better future, and ultimately drive positive change (Liguori et al., 2021; McEwan et al., 2016). Methodologies such as the Adaptive Participatory Storytelling Approach (ASPA) embody this transformative power, allowing for active participation throughout a research process and empowering participants to co-create narratives. Roberts et al. (2022) have argued that this collective approach fosters spaces for deep listening and adaptation, ensuring stories resonate with participants' lived experiences. That outcome aligns with the approach we adopted, where the experiences of flood-affected children have helped generate stories that engage others.

The power of storytelling as a research methodology lies in its ability to reveal hidden motivations, cultural nuances, and the rationales behind behaviours. Stories allow participants to express their lived experiences in their own ways. The approach necessitates distinguishing between stories—what individuals tell, and narratives—how researchers interpret those stories and means acknowledging that stories are also shaped by ingrained understandings of cultural and societal norms, where exaggeration is integral (Rooney et al., 2016). The richness of storytelling as a methodology means that researchers can tap into the tapestry of human experiences, reveal motivations and perceptions that traditional methods may not access, and provide new ways to engage participants and audiences with research processes.

### 2.2 | Background to the project

Following ethics clearances at the University of Hull, the first phase of the project consisted of producing the two 360° videos, Help Callum and Help Sali, based on testimonies and real stories from two flood-affected children. The second phase involved co-creating the associated flood stories educational resources, which were produced via a set of workshops and meetings with stakeholders including children, teachers, agency workers, and flood professionals. In that phase, we adopted a hermeneutic (looping) framework whereby each element of the co-creation process resulted in subsequent reflection and adaptation of the interventions (Hayes et al., 2022; Trajber et al., 2019).

Testimonies by flood-affected children were gathered in another project led and reported by Mort et al. (2016, 2018b), in which researchers used varied creative methods to work with two groups of children affected by the severe winter floods in 2013–14 in the United Kingdom. Using photography, 3D model-making, and individual interviews, we supported participating children to share their flood stories on walks and in conversations around flood-affected landscapes (Lloyd Williams et al., 2017).

The research team then shared data from the project with participating children, inviting them to reflect on what it revealed and on what they felt needed to be changed in flood risk management. That reflective process led to the creation of flood manifestos in which the children listed demands to policymakers and practitioners, which they then presented at stakeholder events (Lancaster University & Save the Children, 2015). A key feature of the manifestos was the children's call for flood education for all that would ensure future generations of flood-affected children would be better prepared (Mort et al., 2018a). That work exemplified both how children's voices can mobilise others to action and how hearing children's first-hand experiences of flooding can be highly effective in engaging audiences, including policymakers (Lloyd Williams et al., 2017).

### 2.3 | Covid-19 impacts on workshop sessions

The project took place during the COVID-19 pandemic. We conducted all co-creation workshops detailed below online using digital, reflexive methodologies, creating safe [online] spaces for participants to reflect on and document their experiences. We used Microsoft Teams and Zoom as our base platform to meet participants and used online whiteboard tools Jamboard and Miro to gather data in real-time during sessions.

Digital reflective methods can be effective for engaging participants who may struggle to communicate their experiences, giving participants a degree of control over the research process and encouraging them to take an active role in collecting and analysing data as it comes through. Such methods help participants to instantly reflect (Onyema et al., 2019).

However, using digital methodologies can have drawbacks related to digital access, privacy, and data security. We worked hard to establish the online workshops as safe spaces using introductory and warm-up activities and providing opportunities for participants to ask questions and give feedback on the process throughout. We ensured all participants were aware that no information created during sessions was to be passed on or used in any other domain without everyone's permission. University ethical and data management guidelines were followed throughout.

### 2.4 | 360° video development

To place users in the centre of the story, witness children's experiences of flooding through their eyes, and hear their stories in their words, the two real flood testimonies from Callum and Sali were fused with 360° video immersive storytelling methods (c.f. Skinner, 2020). We were keen to explore how that approach could be supported by digital tools and educational materials. The aim was to co-create those tools and materials with children and enhance resilience among individuals, families, schools, and communities in flood-prone areas.

The 360° videos were developed by a software developer who used UNITY-3D software, which is a common games development package. The contract brief required the developer to include diverse human characters in animations—important, given the diversity of communities typically affected by flooding events in the United Kingdom (Rozer & Surminski, 2021). However, there was a lack of freely available assets for people of colour and older characters, which meant developing new assets for the project.

Each video comprised several scenes charting Callum's and Sali's flood journeys. Each video was based on their testimonies and was anonymised and conceptualised while incorporating the children's direct quotes in the scripts. Each started with a global view, such that viewing participants could later have a wider view of scenes including Callum or Sali and their positions in their immediate environments. Each then cuts to a view of the same scene but from the child's perspective, and the participant would then hear a voiceover of the child's voice, played by an actor. Each then switched back to the global view, with an adult voice prompting participants to reflect on the scene. For example, they might be asked, "How would you help Callum?" A scene-by-scene description of each animation can be found in Figures 2 and 3.

The outputs were the 360° videos provided as MP4 files. When viewed using compatible players, each scene is shown from a fixed point with audiences able to rotate the camera view in any direction they wish. The format is compatible with VR headsets where the sense of immersion and scale is still enhanced when viewed via a headset.

## 3 | RESULTS FROM CO-CREATION WORKSHOPS

### 3.1 | National Children's Bureau sessions

We undertook two structured workshops with the London-based National Children's Bureau (NCB) to develop and co-create resources with their Young Research Advisors (YRAs) group. The NCB established its YRAs group in 2011 and regularly recruits candidates to be part of the YRA programme, ensuring diversity and representativeness from across the country. YRAs are aged between seven and 18 or may be up to 25 years old if they have special educational needs or disabilities. After being recruited, YRAs are given training on ethics, research methods, and key policy issues to ensure a basic understanding of research projects and an appreciation of why their inputs to the bureau are important (National Children's Bureau). The NCB therefore led recruitment and helped facilitate the two workshops, which were both implemented online.

After we contacted and met the NCB facilitators to discuss the project, they sent an email detailing the project and its aims to their bank of YRAs from across the United Kingdom. We included a link to the Help Callum video as part of the recruitment, so YRAs could get a feel for the project. The YRAs then contacted the NCB to say if they were interested in taking part in the research. It is standard practice for all the YRAs who volunteer to take part in a study to be given a voucher to thank them for their participation and giving up their time. We were keen to support this process and did so by ensuring payments to NCB from our project budget.

The NCB handled all of the liaison with the young people and hosted the workshops on its servers, meaning we did not have any details of the young people's ages or genders or when workshops were being held. Some young people chose not to turn their cameras, engaging only with their voices on, and some did not speak aloud during workshops, working via the chat function.

The first workshop was conducted before we developed the educational resources to accompany the videos. That decision was made so we could understand what young people thought of the flood stories videos, discover what questions the videos raised for them, and ascertain what other resources they thought could augment the effects of the videos. The workshop took place for two hours online in June 2021. Three people from our team were present, along with two NCB facilitators and nine YRAs. We gave some

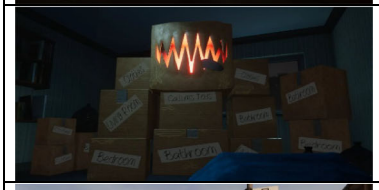
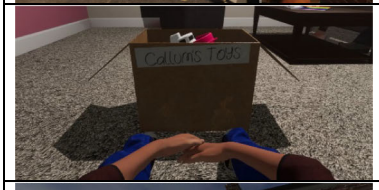
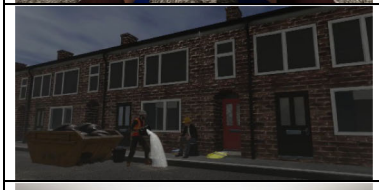
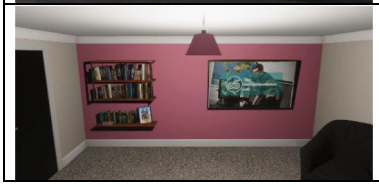
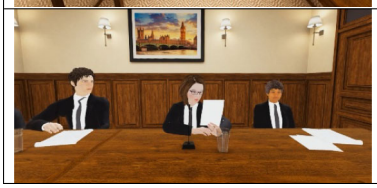
| | |
|---|---|
|  | Scene 1: Callum is at home. Flood water is entering the house. His mum and dad are trying to stop it causing damage. They realise they need to leave. |
|  | Scene 2: The empty house is shown flooded with the family's belongings, including Callum's toy boat, floating on the water. |
|  | Scene 3: The family are living with Callum's grandma. Callum sleeps in a room surrounded by boxes of their belongings. He is scared they will fall on him and has nightmares. |
|  | Scene 4: Callum has to travel to school on the bus alone as grandma does not live near his friends. He is worried about losing his bus money and getting stuck at school. |
|  | Scene 5: The family move back into their refurbished house and Callum is reunited with his belongings. |
|  | Scene 6: The other houses on Callum's street are still being refurbished. Callum gets scared when it rains and angry at builders who pour things into the drains, worried it will cause another flood. |
|  | Scene 7: The family sit together on the sofa in their refurbished house as Callum reflects on his flood recovery story, inviting the viewer to act – "What would you do?" |

**FIGURE 2** Scene breakdown for the help Callum 360° video.

background to the project so they could understand from when flood stories originated and could appreciate how their work augmented that started by other young people. We asked YRAs what they imagined when they heard the word 'flooding' and gathered their responses. The responses included "devastation," "people losing their homes and their food," and "some people might die if they're hungry." Other responses included concerns over the impacts of flooding on "every aspect of life including social life, and loss of stability." Among workshop participants, knowledge of the possible negative impacts of flooding was reasonably sound. However, members of the workshop also said that information about flooding is "not taught about enough in school, you just learn about mass devastation from tsunamis." Some participants said that people tend to "associate flooding with disadvantaged countries, and not with England" and that flooding is "not known about enough as something that happens in England." Reflective dialogues suggested that, in the United Kingdom, flooding is "not given enough airtime [and nor is] the importance of how it can be destructive if it happened to you."

We next showed the 360° videos and associated technology and their use in immersive storytelling before providing an opportunity for participants to watch the Help Callum video in their own space during a 20–minute break without cameras. When the YRAs

**FIGURE 3** Scene breakdown for the help Sali 360° video.

| | |
|---|---|
|  | |
|  | |
|  | Scene 3: The family visit their flood damaged home early in the renovations. Sali is sad about lost belongings, especially sentimental items. |
|  | Scene 4: Sali and her family move into temporary accommodation. Sali is happier as this better suits her dad's needs and she makes friends with the elderly couple next door. |
|  | Scene 5: Sali shares her flood recovery testimony with Members of the UK Parliament at Westminster. With other children with their own flood recovery testimonies, they present their manifestos for change. |
|  | Scene 5b: The end of the animation asks participants to reflect now they have heard her story. Sali asks them "what more do you think needs to be done to help families like mine?". |

returned we put them into two breakout groups, sharing a prepared Miro board with still images taken from each of the seven scenes from the video (Figures 2 and 3). We and the NCB facilitators captured the YRAs' thoughts and suggestions.

We chose to use this method to create vibrant discussions within breakout groups. Interestingly, without prompting, members of the group identified how education can reinforce a spatial disconnect regarding flood risk and exposure: "In primary school you're shown countries in Africa with large scale flooding, and then nothing at secondary school if you don't study Geography." Moreover, in the subsequent large-group reflection session, despite being prompted, none of the NCB group members could think of "anything positive about flooding," with the only positive suggestion being if flooding occurred in an area "it could lead to positive policy change." There are several known positives in relation to flooding, but the NCB group said these are not talked about at school until key stages are taught later in the geography curriculum. The workshop ended with a brief feedback session where a representative from each group shared some key points with everyone. We responded by saying we would take away their comments and come back for the second workshop with suggestions for development based on what they had told us.

The second workshop was held six weeks later with two researchers from our team and two NCB facilitators accompanying the YRAs. Some had attended the first workshop, and some had not. We recapped what we did at the first event and explained how we had created a series of interactive learning hotspots in response to the questions they had raised last time about the Help Callum 360° video. Hotspots were added to each scene of the video and developed in response to the first workshop Miro-board discussions. We invited the second group to turn off their cameras and watch an educational video on how hotspots would work, after which we moved into two breakout groups, again using Miro boards to discuss the potential use of hotspots based on the scenes shown in Figure 3. We asked for feedback on the use of those hotspots, including which could work well, which could be improved, and what else we could add or change. Positive uses for water were also discussed, with participants suggesting

various examples, such as "personal hygiene, keeping us healthy, cleaning, to surviving by drinking water to watering plants and cooking and using water in our leisure activities." Positive aspects of flooding, such as the function of natural wetlands, biodiversity, and floodplain dynamics were not raised in the discussions.

One of the key outcomes from the two NCB workshops was a realisation about how engagement with stories was built around the empathy generated by being immersed in the videos. When asked about the main message, participants responded: "With Callum's eye view it's more intimate and it feels like you are part of the story. The other photo you're just viewing it as an outsider." Additional responses were concerned with "connection," for example, the video "help(s) to be more empathetic—connect." Others commented on how the video gave "young people a voice—impact on young people," and how they thought "it is addressing that there is going to be increased chances of flooding, so people need to be educated on safety and what to do in that situation."

In all the workshops, it was apparent that participants felt the need to "help" Callum and address the issues he was facing. Comments in this regard included: "Who can help that he knows and trusts to help him on his journey?" and "Because his mental health hasn't been good, have some pastoral support after the flood. Support in general for all the available places. Have signposting so that they know where to go and who can help them."

Additional follow-up questions and comments from participants included: "What pastoral support did Callum get to help him? At school and in general? Flood can cause anxiety and stress." Participants identified a need for "Signposting to services that can help [such as Childline, which] children can access themselves." They also requested that we "Recognise the importance and power of the emotional parts—time to reflect on impact and emotions—make sure to keep emotional side as well as containing all of the relevant information." These comments made us examine how we would present information on the hotspots and ensure that any additional information and signposting were more clearly available on the educational resources. A key finding from these workshops was the empathy generated by engagement with the 360° videos and VR immersion (see Yang & Zhang, 2022). Evidence for this empathetic response among our participants included their questions, such as "why would you leave the favourite toy?" and "why did they leave their toy boat?" or "what happens in terms of school and housing—what are the options available to them?" or "what happens in between them leaving the house and returning to the house?"

We closed both workshops by explaining how we would use the feedback to develop the fully functional hotspots and inform the development of our second flood stories 360° video, Help Sali, providing a preview of that new video before finishing the sessions.

## 3.2 | Teacher workshops

We also undertook workshops with secondary school teachers. Using a social media 'shoutout' on Twitter and Facebook we recruited teachers to take part in our study. The Royal Geographical Society (RGS) advertised the study for us in its newsletters, blogs, and social media channels. We advertised the project in Yorkshire's Hull and East Riding teacher forums, including in newsletters school mailing lists, and using known hashtags on social media. We stipulated that we were seeking to work with secondary geography teachers. We aimed to share all the resources created via the Environment Agency's partnership with the Geographical Association (GA). Six teachers initially contacted us to take part in the workshops, but eventually, three teachers from two schools took part (Table 1).

There were four online teacher workshops, each lasting ~100 minutes at the end of school days. We started each by introducing the session aims and creating space for general discussion using Jamboard. Workshops were structured to develop and trial lesson plans connected to the two videos. Following review and discussion at workshops, we revised the plans, which the teachers would subsequently test with their own students. Using the looping methodology detailed above, those plans went through constant revision in response to ongoing feedback from the teachers and their classes.

Teachers were asked to provide feedback on how they and their students had engaged with the flood stories educational resources. One teacher captured and shared their own feedback about how students had engaged and collected information directly from students in an independent teacher-led research session. Such data are invaluable for testing the resource usability without scaffolded support. After showing the Help Callum video to the class, the teacher provided each student with a printout of each question following each of the hotspot scenes. The teacher then

**TABLE 1** Participant school profiles.

| School profile | School A | School B |
|---|---|---|
| Type of school | Community school | Foundation school |
| Admissions | Non-selective | Non-selective |
| Gender | Mixed | Mixed |
| Age range | 11 to 16 | 11 to 16 |
| Students | 752 | 1,491 |
| % eligibility for free school meals in 2023 | 34.4% | 12.1% |

played back the film and paused at each scene asking the young people to write down their thoughts and feelings. The school consented to us being able to use these additional de-identified data, so we updated our ethical approval via minor amendments. The teacher asked the students to give verbal consent to us using this additional part of their feedback in our analysis. The feedback we received was from one Year 9 and one Year 10 geography class among young people aged 13–15.

The teachers who trialled the videos and resources found them to be engaging and effective in teaching students about flooding. During our workshops with them, we wanted to know what they thought about how they teach flooding in the context of the potential afforded by 360° video. We provided three lesson plans that we had co-created via the workshops on Help Callum and asked them to then trial this with their students in a regular geography lesson. They gave feedback to improve our lesson plans in a general sense and suggested how to improve student and teacher engagement. Limits with technology, limited access to headsets in classrooms, and digital divide effects were considerations (see Van Dijk, 2020). However, teachers said the approach motivated students to think about who had what kinds of responsibility for flood management.

### 3.3 | Development of educational materials and resources

Once we had completed all the workshops and compiled the data, we were able to finalise the development process of the flood stories educational pack, comprising the 360° videos, a series of interactive hotspots based on each scene from the two videos presented in a virtual tour software, Kuula, and targeted lesson plans. Using Kuula for the hotspot scenes allows the viewer to explore each scene of the two stories in more detail and in their own way, clicking on questions that interest them or about which they would like more information. We used feedback from the workshops and questions asked by participants to inform hotspot content. These resources and co-created lesson plans have been made freely available.

## 4 | DISCUSSION

Our engagements highlight the point that the 360° videos and resources were informative, engaging, and effective in educating students about flooding. The co-creation process promoted a reflective looping process (Hayes et al., 2022). That process helped us to refine messages and develop resources to address questions young people had raised and to scaffold resources into tailored lessons that address diverse stakeholder needs. This section provides a critical analysis of that journey reshaping debates on action-oriented empathic responses in fostering action on flood resilience.

The NCB workshops revealed a general disconnect among participants in relation to the risk of being subject to floods in the United Kingdom. McEwen et al. (2018) have also highlighted such a disconnect in flood risk, showing how people from varied communities may have different levels of awareness of flood risk and different levels of access to resources and information. Participatory models of engagement with flooding can be used to help to address that disconnect, building awareness of flood risk, and develop effective flood risk management strategies. We argue that enhanced, empathetic, situationally aware, and regionally sensitive education is core to those outcomes. Kopnina (2020) has highlighted how climate change and sustainability education needs to be more locally focused and argued that such education should critically engage with regional challenges in their locale. However, not all young people take geography classes in upper secondary school in the United Kingdom, limiting their flood hazard and risk education, such as the natural functioning of river floodplains. Moreover, most flood education has a science, technology, engineering, and mathematics (STEM) focus, with humanities/social science perspectives or child-centred approaches largely ignored (c.f. Mort et al., 2020). We argue here that a "flood education for all" approach should be adopted that incorporates place-centred holistic education that fosters engagement.

As highlighted above, the teachers found the 360° video engaging and effective in teaching students about flooding, opening up conversations, and acting as a starting point that was relevant and adaptable to either Key Stage 3 or 4. A key element of feedback provided by teachers concerned improvements to engagement and learning among students they described as having lower levels of attainment. Such students were able to "retain information really well – video [is] engaging," and "weaker students were able to relate to the film and talk about the issues from the film." Teachers said that resources allowed students to "think more about hidden impacts of flooding" and that more broadly the videos appealed to the students because of the "fact it was real" and "the storytelling aspect" helped the work "to engage across all ability groups." They said that the resources were a "bit different … [and used] not just a worksheet, ppt, has lots of possibilities to fit into the curriculum or as a standalone. The students liked it and if they do then the teacher does." And they highlighted the point that the "360° element is really effective. Less academically-able students were able to engage strongly through this medium and really access the story and the issues arising. The power of the 360° is that it opens up the scene

in a different way—investigative, probing, and seeing new angle.''

These findings are similar to those observed by Liu et al. (2020), who have shown how immersive virtual reality-based classroom activities can positively affect students' learning performance. In a parallel study with experimental and control groups, they found that students engaged with VR as part of the educational mix had higher academic achievement outcomes than the control group who were taught the same content using traditional teaching methodologies. Such engagement and motivation are regarded as important in generating enhanced learning outcomes (Hsieh, 2014).

Turning to what could be added to the Flood Stories resources, the comments we received centred on flood planning and acting—with comments such as ''Why haven't the community thought of flood planning and did the parents really know what was going on with the floods—were they prepared?'' Young participants also felt the videos did not provide enough information on the impact of flooding on different groups of people. They wanted to know more about how flooding affects people of different ages, genders, incomes, and abilities. Finally, young people in the NCB workshops felt the videos did not provide enough information on what people can do to prepare for and respond to flooding. They wanted to know more about things like flood insurance, evacuation plans, and how to clean up after a flood. One stated: ''I didn't know that there were things I could do to prepare for and respond to flooding, like getting flood insurance and having an evacuation plan.'' Such an orientation to take positive action and think about the future is a key outcome in building resilience through preparedness.

Improved flood resilience has been a priority for the UK Government for several years, with enhanced community engagement in flood and coastal erosion risk management being at the core of delivery plans and strategies. There are various approaches to community engagement, each with challenges and benefits. Lundy's (2007) model of children's participation, based on Arnstein's (1969) foundational work, is a key typology of citizen engagement to encourage more enlightened dialogues, with participation in decision-making and partnerships key to providing transfer of a sense of ownership and control with regard to issues at hand. Critiquing this approach, however, we argue that there is an enabling step where education is key, such that communities are able to holistically understand the issues and the opportunities to shape their response in effective ways. We also argue that ensuring participation and engagement and building empathy in the education journey are key to fostering action. As outlined elsewhere, empathy can span geographies and across time and spatial scales (Hayes et al., 2022) and the work herein has shown the value of a 360° video-based based approach can here in regard to wider reach.

## 5 | CONCLUSION

Our research has shown that 360° videos that explore real children's flood stories can be powerful tools within flood education programmes, initiating empathy, enhancing learning, and fostering action. Our approach built among participants a strong sense of solidarity with Callum, who were concerned for his wellbeing and emotionally connected to his journey and experiences. The use of real flood testimonies supported participants' engagement, legitimising stories and experiences detailed in both 360° videos. The work has shown how immersive storytelling could bring participants closer to often abstract ideas about flooding and experiences of being flooded, making them seem real. The videos and related lesson plans helped create a sense of community among young people, as they shared their own experiences of and feelings about flooding. We posit that the 360° video delivery method also made it easier for all participants to engage with the topic, materials, and learning objectives. Finally, the approach provided tools to make changes, notably in terms of personal agency and empowerment, knowledge of positive actions, empathy, and fostered a desire to see changes in flood preparedness in their own communities in the United Kingdom.

The Flood Stories educational resources we produced have proven effective in creating conversations but have shown the need for facilitators to support such dialogues, so students are empowered to translate learning into local actions on flood risk. The approach can help participants move beyond communicating flood risk to enhance flood preparedness through practical action to build resilience. It has also shown how important it is to co-create the resources in partnerships ensuring relevance to the needs of the target audiences.

Finally, and aligned with other research on technology-enhanced education, two other key outcomes have arisen. One has been to establish how students experiencing lower levels of educational attainment in schools were more engaged across the sessions and their learning outcomes were enhanced as a result. The other has been a realisation about the need to think about flood education beyond the bounds of teaching flood risk through STEM subjects and consider how flood education is needed for all. Ongoing work from our projects will extend the outcomes herein to explore how resources can travel across cultural and international dimensions to stimulate global conversations among young people about how flooding impacts different groups of people and communities around the world.

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## ETHICS STATEMENT

All work was presented and approved by the University of Hull's Ethics Committee.

## DATA AVAILABILITY STATEMENT

Datasets and the videos are all online as well as the learning resources and teaching packs: https://360lab.lboro.ac.uk/project/flood-stories/.

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