Chapter 8

Actors with Agency: Immersive Science Theatre and Science Identity

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Casting the audience as the lead characters in a dramatic production offers exciting potential to create transformative experiences. This chapter explores this approach from the perspective of providing informal science learning (ISL) experiences which are highly engaging for audiences who are demographically less likely to access ISL.

Children living with socio-economic disadvantages and some Black and Black-heritage children are under-represented in Science, Technology, Engineering and Mathematics (STEM) subjects and careers and tend to see science as 'not for me' (Archer, Moote, Macleod, Francis, & DeWitt, 2020; Archer et al., 2021; Gutman & Akerman, 2008; IET, 2008; McDonald, 2014; Reiss & Mujtaba, 2017; TISME, 2013). The evidence surrounding this lack of representation has been incorporated into the epistemological paradigm of 'science capital', which is based on Bourdieu's concept of 'cultural capital' and was developed by Louise Archer and colleagues. In her work, Archer suggests that supporting students to build a positive science identity might bolster science capital, and that one way to enhance positive science identity is through successful engagement in informal science learning (ISL) activities (Archer, Dawson, DeWitt, Seakins, & Wong, 2015; DeWitt, Archer, & Mau, 2016).

As a response to this research, the authors founded a novel annual science and arts festival (SMASHfestUK 2015 – present) as a platform for community action research exploring narrative-led approaches to enhancing science identity through ISL. SMASHfestUK was developed using co-design and co-production methodologies, with designers and producers working iteratively with audiences and stakeholders to increase the engagement of under-served audiences. Through a combination of the co-design process, and a literature search of the available evidence about developing science identity and building science capital, a set of principles was derived upon which the festival was designed (Keith & Griffiths, 2021).

Although each festival comprises multiple events, including both drop-in and ticketed activities (such as plays, arts, crafts, comedy, interactive installations, games and exhibits), they are all linked by an

overarching storyline of a fictional natural disaster set in the locale. Audiences are invited to help 'save the world' from these existential threats, putting them at the centre of the experience as people who have (or who can develop) agency to change the outcome of the disaster, and therefore change the future through science and arts-based interventions.

A wide range of theatrical genres have been explored over iterative festivals, demonstrating deep engagements and providing opportunities to explore aspects of representation, community-context and complex interactions with STEM and society in meaningful frameworks. Theatre, narratives and, increasingly, immersive interactive experiences emerged as key drivers for inclusive engagement with evaluation results suggesting that the deeper the immersion in the storyline the greater the engagement of the audience. As the level of interaction and the personal agency within the production increased, so the science identity of the audience was built or reinforced. As a direct result of the evidence, the event format was changed in 2019 (after 4 years) from a semi-immersive 'festival' into a fully immersive 'experience', *Space Plague*. The express intention of *Space Plague* is to immerse audiences within the storyline in a quest for narrative transportation, such that audiences would become so present within the immersive world as actors with agency that even once the performance had ended, positive attitudinal and behavioural changes towards STEM subjects might be achieved (Green & Brock, 2002; Keith & Griffiths, 2020).

In this chapter we review barriers to informal science learning (ISL) opportunities experienced by marginalised and underserved communities, and how the SMASHfestUK co-design-led approach successfully overcame them. We also explore the role of immersive experiences as a highly effective way of transforming attitudes and behaviours in real life and how the re-imagination of audiences as actors with agency in an experience or performance can contextualise abstract STEM knowledge and processes, and may lead to narrative transportation (Griffiths & Keith, 2021; Keith & Griffiths, 2020, 2021).

8.1 Overview of science theatre in UK context

Much theatre that has been inspired directly from public engagement with science in the UK is based on the experimental science demonstration. This rich history extends back to the Enlightenment and carries on today at festivals, museums and venues such as the Royal Institution (Bensaude-Vincent & Blondel, 2008; James, 2000). Although such experiences can be a good way to engage publics with science, they also tend to attract audiences who are white, affluent and already

engaged with science (Dawson, 2019; Jensen & Holliman, 2016; Kennedy, Jensen, & Verbeke, 2018). Further, there is uncertainty over their long-term effectiveness as an engagement tool, and it has been argued that, 'the legitimacy of public engagement does not just depend on its inputs, but also on its outputs' (Stilgoe, Lock, & Wilsdon, 2014, p.6).

More recently the role of storytelling in science communication has begun to be more deeply explored. Storr in *The Science of Storytelling* provides a comprehensive review of storytelling from a scientific perspective, extending the possibilities for how it may be applied in science communication. Storr recognises the role of immersion in stories, saying 'transportation changes people, then it changes the world' and concludes; 'to accept a story's challenge and win is to be a hero' (Storr, 2020). In literature aimed at science communication, however, the focus tends to fall on how scientists might structure and deliver communication of their research through story, rather than the effect on the audience (Kelesidou & Chabrol, 2021).

The role of the audience in science theatre has evolved; the presence of an audience is broadly considered as central to the definition of theatre and a key tenet of immersive theatre is the role of the audience in the performance and performance space (Freshwater, 2009). Traditionally, the proscenium arch formed a barrier between audience and performance, with audiences watching passively in seats (Naturism) largely unobserved by the performers. Brecht's *verfreundeseffekt* [alienation effect] distanced audiences from the story and its characters, forcing them to observe and think rather than empathise. In some more recent theatre practices, the fourth wall of the theatre may be broken; audiences might be directly addressed by performers, and become complicit members of a theatrical plot. Iterations of this kind of performance have expanded to include participatory, site-specific and/or promenade works, in which the audience is not only complicit in the plot, but moves around, (sometimes freely, and sometimes guided) participating in scenes through their own volition and perambulation (Brecht, 1964; Machon, 2013; Woods & Banham, 1996). Commercialisation of this form of promenade and site-specific theatre accelerated in the 2000s, with Punchdrunk theatre company's acclaimed production, *Sleep No More*, a visceral reimagining of Macbeth, which sets the audience roaming through a 1950s noir-style hotel, in the role of 'guests'. (Biggin, 2017). This focus on audience and experience development has opened opportunities and a potential platform for engagement with science, which is now beginning to be explored (Alston, 2013; Lopes Ramos, Dunne-Howrie, Maravala, & Simon, 2020).

8.2 Science theatre: the SMASH-UK[1] and SMASHfestUK programme

Between 2015 and 2018 SMASHfestUK produced four annual narrative-lead festivals with a focus on local inclusion, which extended to smaller satellite events, 'pop-up' festivals and was accompanied by a schools' outreach programme. A major focus within each festival/event was to produce theatre driven by SMASHfestUK principles and design process; we aimed to create meaningful stories, rich in community connection and representation, manifesting complex interdisciplinary STEM knowledge, in accessible ways. A key principle was to establish the events in local public spaces in the heart of the community we sought to engage, working with local people to develop and deliver the productions. The intent in doing so was to try to shift attitudes from 'science is not for me' into 'science is for me,' by ensuring events were meaningful for, resonant to and located within the local community.

Each festival comprised multiple events and activities related to the story, of which a number would be considered theatrical performances in a traditional sense. These included two stage plays, both performed in the round (*Cosmic Jives*, 2016/2018, and *Rapture*, 2017), in which the protagonists were representative of local communities, each featuring young, black females from South London in lead roles and each set partly in the local community of Deptford in South East London; the location of the play's venue. Local youth drama groups were engaged in the development and delivery of the productions, conferring a sense of ownership and a motivation for family and friends to attend. The reflections of participants in the creation of the work were telling: Seraphina Beh, 'Rory/Aurora' the lead character in *Cosmic Jives* wrote on social media platforms: *'*Shout out to all who came down to support. And a huge shout out to #smashfestuk for an incredible festival and for inspiring young minds…Encouraging young minds to be enlightened in the world of science'. Alice Knight, the director, commented: *'*Socially and politically, SMASHfestUK aligns totally with the sort of work I want to make as an artist, as it is free and inclusive. I believe in the message underpinning the play completely, which is to do with the empowerment of women and encouraging diversity in a field that historically has been the domain of white middle class men.*'*

[1] SMASH-UK CIC was established in 2018 to formalise the organisation within which SMASHfestUK was developed and operated. The development, research, production and outreach programme that embodied the festival emerged from a collaboration between The Refinery (a media production company) and Middlesex University, with the University of Greenwich later joining the collaborative partnership.

A third 'personalised and localised' theatrical experience included an interactive 'courtroom' drama (*The Curious Case of the Flood in the Night-time*) in which the audience played the role of the 'jury' at an inquest into the mysterious death of a fictional local South London man. On two occasions narrative-led variety shows were also produced which played out the overarching disaster storyline with localised references (*The End of the World Show*, 2015, and *STEM the Tide*, 2018). In addition to staged performances, several immersive and interactive experiences were also developed and produced. These included *Survival Village* (2015/16/17), *Living in Space* (2018), *Survival Supermarket Sweep* (2015, 2016) and *Escape the Swamp* (2018). In these experiences, some of which were gamified, festival visitors as actors with agency could save themselves and/or the world through engaging with creative STEM problem-solving.

8.2.1 The 'backstage' process

As mentioned, each genre of event was created according to the overarching SMASHfestUK principles which included a) being created 'in the community, with the community, by the community', b) included representation of 'people like me' foregrounding facilitators, practitioners and actors representative of the local community (black and black/mixed-heritage), c) being hyperlocal, that is, connecting the people and places of the community to the unfolding story and STEM content, and d) promoting narrative transportation to facilitate transformation of identity, attitudes and behaviours through the experiences. These principles, which were based on evidence from a review of the academic literature on successful engagement methods, were developed into a dynamic model for inclusive engagement, called SCENE (STEAM, Community, Entertainment, Narrative, Enquiry – see Figure 8.1). The SCENE model along with the co-design process served two functions; they both helped to generate and develop ideas for productions and were also an integral part of the evaluation process. Each annual cycle with its accompanying storyline generated a series of productions which were evaluated, and learnings fed-back into the co-design process for the following year so that each festival was learning from and building upon the previous years. The efficacy of the approach was captured by Tyreese Hines, one of our 2016 'Young Explainers':

> 'It's great that there are events like this that bring a chance to people who wouldn't usually engage. Young people liked how the Festival was on the High Street - they don't see these sorts of things in the rigid environment of school and they can't explore these sorts of ideas. I enjoyed explaining ideas to children and parents and I learned a lot of new things that you don't usually put together in the conventional sense. The arts make it all more creative and

putting things together in different ways reveals the overlaps. For people who don't engage with science it hooks them in and makes them want to find out more.'

In employing the SCENE co-design process, each festival is considered as a live 'prototype' and a development cycle. Pre-event development is driven by co-design and co-production with participating stakeholders and post-event evaluation learnings are incorporated into the following cycle. Stakeholders, including researchers, practitioners, pupils, teachers and community members, come together in a series of workshops which start with developing and ideating the overall vision for the next festival and work through cycles of event development over multiple workshops, right down to the detail of the final production. The SCENE model acts as a guide throughout. There is a focus on asking 'why, who, what, where, when and how' for each event, and incorporating learning and science capital building outcomes into each production. The considered use of the SCENE co-design model every year has been vital in producing effective cycles of reflection and learning (for more detail on the model, process and development see Keith and Griffiths, 2021).

[Figure 8.1 about here]

Figure 8.1 SCENE model incorporating the co-design process ACKNOWLEDGEMENT OF 1st PUBLISHED

Findings from SMASHfestUK events held from 2015-2018 suggested that semi-immersive narratives were not only effective in engaging underserved and under-represented audiences, but that some forms of narrative transportation may be occurring (Jarvis, 2016; McKenzie, 2015; Simons, 2017, 2018). SCENE also showed that a combination of enquiry-based learning and immersing audiences in meaningful stories allowed them to experience STEM agency, building positive science identities. Given the success of the festival in these areas, the next development step was to test the efficacy of the SCENE model when applied to a fully-immersive experience. The experience *Space Plague* was developed to explore this emerging effect on audiences, with the working hypothesis that positive effects on science identity observed in the 2015-2018 (semi-immersive) festivals would be enhanced by a fully immersive experience (Keith & Griffiths, 2020).

8.3 Space Plague[2]

[2] *Space Plague* was funded by the Science and Technology Facilities Council 'Nucleus Award', the Royal Academy of Engineering 'INGENIOUS', the Arts Council and the British Science Association. It was developed in partnership between SMASH-UK CIC, Middlesex University, the University of Greenwich, University of the Arts London, the Rutherford Appleton Labs - Diamond Light Source and ISIS Neutron and Muon Source, the

Space Plague is an immersive piece of promenade theatre, based on learnings from SMASHfestUK events 2015-18. The fundamental focus on co-design continued across pre-production and production phases, engaging multiple stakeholders (children, parents, teachers, students, scientists, artists, science-communication practitioners) in co-design workshops. The *Space Plague* experience was first delivered in July 2019, as part of Bradford Science Festival in City Park, and in Deptford, February 2020, as a stand-alone site-specific event taking place in a shared library/school building. The Deptford production developed the *Space Plague* experience integrating learnings from audience feedback and evaluation from the Bradford (pilot) production, and as the most developed version, will be discussed here.

Space Plague Deptford took place over an eight set series of rooms over two inter-linking venues; The Deptford Lounge, a library and community space which shares a building with the local primary school, Tidemill, and a marquee in the public square outside the building. The average audience cohort was 12 people, consisting of an average minor audience age of 9 years old, plus participating parents, with 1-3 scientists, actors, facilitators, or a mix of these practitioners, in each room. The practitioners guided the story and facilitated the delivery of the activities. The integration of interactive activities within the *Space Plague* story was directly linked to the locale within which production was delivered (Bradford 2019, Deptford 2020; for example with audiences mapping disease outbreaks epidemiologically on maps of their own local area). This created a coherent holistic experience with meaning and resonance for visitors, and acted as medium to explore self-identity in the context of the narrative. Instructional information and exposition was required in each room, but this was kept contextual to the story with all information interwoven meaningfully into the overarching narrative.

Audiences entered the 'onboarding centre' and were asked to sign-up to take on the role of an 'Emergency Response Team' whose roles were to help address a sudden pandemic.
In the onboarding centre, facilitators, in character, dressed audiences in branded 'hazmat' suits and instructed them to watch a (mock) news report. The news report (featuring local children - co-created and filmed in the community) laid the backstory for the performance, explaining that a novel

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Structural Genomics Consortium at the University of Oxford, the British Ecological Society, the National Science and Media Museum, Riverside Youth Club/UnCover and TRAMSHED. You can watch the (Mock) News Report introduction here: https://flic.kr/p/2ixy3JJ and the 'Hero's Return' film from *Space Plague* here: https://youtu.be/yTa67OE-GTA

disease linked to a local meteorite shower was spreading locally, causing ‘zombie-like’ symptoms. In the subsequent ‘Meteorite Analysis Laboratory’ the audience had to predict meteorite impact positions from incomplete coordinates using mathematical triangulation. This activity was facilitated by a (fictional) astronaut ‘calling in’ from the International Space Station, alongside academic mathematicians in character as ‘UK Space Agency’ staff. On successfully deriving the meteorite impact zones from incomplete coordinates (using triangulation processes), and plotting the impact zones on a map, the audience were taken via a transitional scene (designed to break the link with the ‘real’ world), to an ‘Emergency Field Hospital’ where they helped a hapless medic to assess a ‘zombified’ patient through differential diagnosis and analysis of clinical signs and symptoms. At the medic’s urging, they promenaded to the next room where they used epidemiological techniques to map local addresses at which patient cases had been reported, revealing that they were clustered near ponds. This led the audience to deduce that a water-borne insect may be spreading the disease. To test their hypothesis, they carried out microscopy on water samples from local sites, discovering mosquito larvae in some. The audience deduced that mosquitoes must be the insect vector that is transmitting disease. DNA ‘barcoding’ from the mosquitoes allowed them to ‘reverse engineer’ a pathogenic protein sequence which is identified as a candidate molecule from which a vaccine can be developed. They ‘tested’ the vaccine candidate, using a model of a particle accelerator, based on the UK’s Diamond Light Source, and scientists told them it would make a successful vaccine but revealed that this may take several years to develop, manufacture and deploy globally. The final scene took them to a ‘Crisis Room’, in which two actors involved the audience in making critical public health decisions, such as prioritising government spending on drugs, quarantine and lockdown decisions, and how to prioritise vaccine recipients as immunisation is rolled out. The experience climaxed with the audience able to ‘save the world’ through their own actions and decisions.

A film was played to complete the experience and portrayed a photograph of the audience being flashed around the globe on billboards, screens and in magazines and newspapers, while a global leader thanked them for saving humankind. This was achieved by taking a photograph against a green-screen during the sign-up process and incorporating it into a premade film template while they promenaded through the experience. We believe that this ‘sealing of the deal’ finale, confirming the audience members as ‘actors with agency’ with public/global recognition of the part they have played in ‘saving the world’ was important in cementing their personal narratives and embedding identity.

8.4 Reflections, lessons and challenges

Within the cycles of reflection and co-design, an emergent effect was observed - that children engaged strongly with the stories and would develop their own personal narratives around it, with one parent visitor noting, 'I think the immersive aspect was the most important. The kids were constantly engaged and it helped get the message across'. A student engineer who participated in the co-design process and delivery of the event added, 'The importance of role-play struck me… As someone from a BAME background myself, I see the importance of making STEM exciting and creative as well as informative as I was often put off and not interested by STEM as a child and it's events such as SMASHfest which allows children to understand concepts in an engaging manner.' Evaluation data has shown that the effects on STEM identity and science (STEM) capital of these immersive experiences may be significant. An individual response by a child to the question 'what did you learn today' concluded, after the *Space Plague* experience 'That I AM a scientist!' (their capitalisation) (Keith & Griffiths, 2020).

Space Plague 2020 is, to our knowledge, the first time that this kind of immersive experience has been developed and delivered with the specific intent of engaging underserved audiences and as a vehicle for ISL for children. Results suggest not only that such immersion is effective in engaging audiences, but that it is also effective as a vehicle for informal learning and that it appears to positively affect attitudes in real life towards STEM subjects. Having piloted this experience we are currently exploring immersion using digital technology (web-based and virtual-reality (VR) to assess whether it can have the same transformative effect on attitudes and learning in young people and families. Critical to this is an exploration of the importance of place and belonging in narrative transportation and how important personalising events and experiences was in the success of the live events. We believe that the localisation effect (i.e. using local maps and data when doing epidemiology, and making reference to local landmarks in the narrative) was vital in encouraging audiences to see the experience (and therefore STEM) as 'for me'. Archer and colleagues have recently developed a toolkit for teaching using methods to boost science capital in the formal learning environment in school (Archer et al., 2020). This toolkit urges teachers to take the same approach of localising and personalising science for students as SMASHfestUK took to ISL. The challenge now is creating digital engagement opportunities which feel similarly personalised and localised.

The SCENE Model, as a method for approaching ISL planning for underserved audiences and a tool for tailoring those ISL experiences, has been a successful approach for development and delivery of SMASHfestUK generally, and for focusing on theatrical and immersive experiences, with co-design and co-production approaches underpinning visioning and development. These approaches were successful in engaging diverse participant communities who are underserved and under-represented in ISL, as both creators and audiences. Continuous iterative prototyping and testing, including the 'who, what, why, where, when' approach has been vital for effective and sensitive development and production, and we believe that the SCENE approach will be transferable to other forms of theatre and ISL. Within this process it is important to recognise the requirement for disciplinary diversity - design, production, writing, dramaturgy, performance, technical, management as well as primary, secondary and tertiary educationalists and students, STEM specialists and engagement professionals, bringing the specific expertise necessary to create compelling theatre, and providing a diversity of thought, experience and background.

While the lessons have been positive in terms of method, process and impact, we recognise that there are significant challenges in employing the approaches described. Human, physical, financial and temporal resource requirements are high and the development and delivery process is complex. The usual cost of entry to immersive experiences reflects this, often putting them out of the reach of many socio-economically disadvantaged communities. The complete immersive production, co-designed and produced with and within each community, may be outside the scope of many initiatives, but we hope that some of the learnings and insights from the SMASHfestUK process and outcomes might be helpful across the diverse fields of public engagement, science communication and ISL. Alongside the procedural and logistical challenges, it is critical that we explore and understand the use and misuse of powerful effects such as narrative transportation within education and ISL, and consider the potential for intensification of these effects within virtual reality environments. Immersion can be a powerful tool in the hands of skilled creators, and immersive technology such as VR has the capabilities to enhance equity, diversity and inclusivity (EDI) in the digital space. If EDI is not foregrounded by creators, however, immersion has potential to do harm and the development of ethical guidelines for immersive creators would be welcomed. In developing such frameworks, insights from, and the application of, SCENE principles and approaches might be beneficial. The transformation of attitudes and behaviours through immersion in gamified stories and the narrative transportation that occurs as a result offer possibilities of a more inclusive and

positive engagement landscape within STE(A)M, but who is telling the stories, about whom and for whom will define how effectively they impact the widest range of audiences and society itself.

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