Supplemental Material: The Main Course Was Mealworms: The Epistemics of Art and Science in Public Engagement

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Supplemental Section 1

The Practice Turn in Science Education

Science has long been conceptualized as a set of cultural and social practices [1,2,3], yet most students still experience it as a litany of settled, disconnected, and seemingly esoteric facts and routines [4]. This static positioning of science has been named a major factor in the lack of diversity and inclusion in STEM academic and professional fields, and has led to calls for making science more clearly relevant to young people's interests [5].

While, at least since Dewey's time, progressive science education has sought to engage students in the processes of doing science, or inquiry, research has found that inquiry science in school is often limited to investigation, and sometimes discovery, seldom involving core scientific practices of argumentation [6]. Moreover, school inquiry is often organized towards the same "settled facts" that fail to capture the imagination of so many young people.

In response, many science education reforms around the globe are reframing the curriculum to illuminate the social relevance and active processes of science. This "practice turn" in K-12 science education has emerged from concerns that the school curriculum is typically "a mile wide and an inch deep"--- leading to educational approaches that stress conceptual recall over deeper learning [7,8]. The practice movement is a response to two large-scale trends: First, given that technology has dramatically transformed our relationship to information, rote memorization is no longer seen as essential to academic or workplace success. Second, investing in critical thinking and discipline-based reasoning is seen as a better bet at a time when the future of the workplace and civic life is rapidly changing.

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Supplemental Section 2

Theoretical Approach: Immersive Storyworlds and Bakhtin's Carnival as a Contexts for Learning

Guerilla Science adopts many different approaches to engaging the public with art and science---from gallery exhibitions to talks to sound installations and more---but here we focus on its programs that incorporate the theatrical or carnivalesque elements of immersive storyworlds.

Immersive storyworlds place participants as agents or characters in aesthetically- and emotionally-saturated fictionalized worlds. A growing body of work includes theatrical experiences like PunchDrunk Productions' Sleep No More, ComicCon fan events, and Escape Rooms. These experiences are characterized by branching plot lines that allow for varying degrees of improvisation and authorship by participants. In taking up roles within the storyworld, participants engage with a range of ideas or concepts as well as practices and interactions [1]. Jenkins describes both interactive and participatory storyworlds: interactive approaches provide choices within a framework (typical in many video games) and participatory is structured in ways that allow participants to fundamentally change the nature of the experience, as is the case with Guerilla Science [2]. Scholars writing about storyworlds note that the experience rewards participants for their existing expertise and knowledge (legitimating their value in a communal activity) and provide opportunities for accessing new insights and skills [4,5,6].

To better understand the immersive storyworld as a context for learning, we draw on Bakhtin's work on carnival [7]. Briefly, carnival is a form of cultural production that leverages theatrical elements (such as costume, drama, spectacle, comedy, and parody) and typically emphasizes the body and bodily functions (usually scatalogical and/or sexual) to upend power structures, forge new social connections, and provoke dialogue. Carnival sparks excitement, curiosity, and a leaning in towards "that which is not yet" [8].

A carnival is a moment when everything (except arguably violence) is permitted. It occurs on the

border between art and life, and is a kind of life shaped according to a pattern of play. It is usually marked by displays of excess and grotesqueness. It is a type of performance, but this performance is communal, with no boundary between performers and audience. It creates a situation in which diverse voices are heard and interact, breaking down conventions and enabling genuine dialogue. It creates the chance for a new perspective and a new order of things, by showing the relative nature of all that exists. ... On an affective level, it creates a particular intense feeling of immanence and unity – of being part of a historically immortal and uninterrupted process of becoming. It is a lived, bodily utopianism [9].

In our study, we are documenting the ways that Guerilla Science uses the theatrical dimensions of carnival, in the format of immersive storyworlds, to invite non-science affiliated publics to engage in the epistemic practices of STEAM, as processes of what Bakhtin called ideological becoming. That is, where participants internalize, integrate and relate scientific perspectives to their own evolving worldviews and understandings [10]. In the context of STEAM, this includes coming to see or create the relevance, salience, and meaning of science in their lives, thus setting the stage for future and possibly ongoing engagement with science.

We capture these insights using Bakhtinian discourse analytics that, among other things, identify moments of "double-voicing" where members of the public following branching narrative arcs within the storyworld and begin to use the words, phrasing, or stances of the presenting scientists or artists, and vice versa where the presenters integrate words, phrasing, and stances of participants. These instances represent moments where, through the recognition and adoption/adaptation of one another's ideas or positionality, people co-construct shared meaning. Our study seeks to understand how the arts (in this case, the theatrical/carnivalesque dimensions of the storyworld) create the space and opportunity, the invitation and even the expectation, for engaging in epistemic practices that can lead to such dialogic meaning-making.

Scholars have used Bakhtinian conceptions of carnival to study learning in a variety of contexts, including language learning in elementary classrooms [11,12,13], early childhood learning [14], second language learning [15], drama instruction [16], learning in museums [17], and science learning [18].Typically this involves role-playing where the student becomes the teacher, taking on the trappings of authority and expertise, and in the moment representing their understandings of the ideas or practices that their teacher has been engaging them with. Researchers have explored how these inverted power dynamics, in the context of play, support agency and create opportunities for learning.

Beyond its potency as a means of realizing immersive storyworlds, carnival --- and the associated festivals which have descended from them --- plays an important role as a form of cultural production that is realized, albeit temporar-

ily and transiently, in physical space and time. This is because, during carnival, "the unlikeliest of people [are brought] together and encouraged [in] the interaction and free expression of themselves" [19]. The localized mixing of different groups facilitates, if not actively invites, participants to reconsider their social place. For Guerilla Science that means shifting their positionality, from novice to knower, vis a vis science. Historically, during the Middle Ages and Renaissance, the king, nobles, members of the Church, and the "working" orders would meet in the market place and, in acts that defied and subverted the rigid feudal and ecclesiastical hierarchies of time, exchange their roles: "A jester was proclaimed king, a clownish abbot, bishop, or archbishop was elected at the 'feast of fools,' and in the churches directly under the pope's jurisdiction a mock pontiff was even chosen." [20]. At the Entomophatron, the participant's own physical experience of ingesting insects becomes the source of the dialogue about scientific issues and facts related to sustainable agriculture. Meaning-making is dialogic between participant and presenter. Guerilla Science events emphasize bodily and emotional risk and daring -- as in eating insects for most Americans visiting a country fair.

Festivals prove to be ideal places for such carnivalesque experiences. In particular, but not exclusively, as in the case studied here, the modern rock and, later, electronic music festivals that came into cultural prominence during the countercultural revolution of the 1960s. Contemporary carnivals, found in Rio, Notting Hill, New Orleans, and many other places, and most festivals are "liminal" spaces, removed from the mundane existence of everyday life. They offer an opportunity to step outside the bounds of everyday identities and a chance to inhabit new roles and ways of being. Indeed, they even offer a chance to experiment with "identity politics that may often be less feasible and acceptable --- and in some cases socially circumscribed --- in everyday settings" [21].

Modern festivals serve as holistic leisure experiences featuring varied programs of music, comedy, shows, and other cultural attractions that include carnivalesque performances. While most festivals are commercial ventures, highly constrained by profit and loss [22], they, like carnival, also serve as critical cultural foci-points that bring together diverse members of a society around common interests, identities, and pursuits [23]. In the case of the Dutchess County Fair, these are primarily the agricultural products, practices, and associated foods that form a critical social and economic component in the communities of the people who come to the Fair. In the case of music festivals such as Glastonbury (UK), Anderton [24] ascribes the presence of " 'healing' crystals, incense sticks, ornaments and temporary henna tattoos" frequently found at the concession stands to the common cultural reading of such festivals as being tied into "into notions of the 'Woodstock Nation' or of New Age, Aquarian, or hippie ideals and lifestyles in general," not least by its attendees, who identify as such. That is, festivals bring together geographically diverse people of different ages, castes, professions, and classes around a common cultural theme. At both carnival and festivals there are people who are therefore distant to science (having come

for reasons that are – with the exception of science festivals, broadly speaking [25] – unrelated to science). This means that by synchronizing and signaling a form, feel, and design of cultural production that aligns with the expectations of festival-goers, Guerilla Science can bring science and scientists into contact with people in a way that does not violate what may be their preconceived expectations of where science and scientists should be.

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