The potential of interactivity and gamification within Immersive Journalism & Interactive Documentary (I-Docs) to explore Climate Change Literacy and inoculate against misinformation.

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Abstract

This paper uses a content analysis methodology to investigate the potential of immersive journalism and interactive documentary (I-Docs) to cover climate change content. Interactive documentaries convey information in many innovative formats; yet changing patterns of media consumption and the negative impact of misinformation can reduce their communicative effectiveness. Therefore, this article explores how we can identify different interactive structures and theoretical frameworks to help ensure I-Docs leverage the potential of emerging techniques to communicate climate change content effectively. This is increasingly important, as climate change predictions become exponentially severe, and misinformation continues to distort the scientific consensus surrounding climate change during the Anthropocene.

We investigate the thematic and structural properties of three interactive documentary works: 'The Last Generation: Climate Change and the Marshall Islands' (Worth & Mizner, 2018), 'This is Climate Change: Melting Ice' (Danfung & Strauss, 2018) and 'Offshore' (Longfellow & Richards 2013). Our results show how these divergent examples of I-Docs sit within current frameworks of Immersive Journalism and can use complex, non-linear narrative structures to explore environmental issues. We argue that the gamification of I-Doc work and the embedding of inoculation techniques offer the potential to engage audiences and reduce their susceptibility to climate change misinformation.

1.0 Main Text - Introduction

Interactive and immersive media has the potential to communicate environmental journalism to new and diverse audiences. Podara et al. (2021) discussed how evolving media technologies can generate new concepts and create media cultures that promote engagement and complement traditional media, while Pavlik (2019) suggested that 'interactive' content has become a label for emerging journalism practices, often those which encourage active user engagement in the content or visual story elements. Interactive technologies such as immersive 360° video, or computer-generated virtual reality journalism have been hailed as possible 'empathy machines', promoting greater emotional responses through virtual environments and immersive video experiences (Archer & Finger, 2018; Toursel & Useille, 2019). One such format that has progressed significantly over the last 10 years is the interactive web documentary, which can use innovative online storytelling techniques to cover important topics (Ducasse et al., 2020) and has the potential to communicate to digital native audiences in a familiar, user adaptive fashion.

Yet, despite the prevalence of interactive journalism online, these emerging practices are developing within challenging circumstances. The "battle for people's attention" (Ducasse et al., 2020:1) means while evolution is essential, reaching and engaging new audiences is not guaranteed. Although innovation and experimentation has been a constant within interactive and immersive digital journalism throughout the 2010s (Dowling, 2021; Jacobson et al., 2016), evidence suggests that increasing interactivity does not always result in a more engaged or well-informed audience. Studies show that increased interactivity, especially via social media, can help increase political polarization, enable the spread of fake news (Allcott, Gentzkow & Yu, 2018) and widen divides on environmental issues (Hart and Nisbet, 2011). The desirability of multimedia content online is also debated, as its convenience is heavily linked to the users' viewing situation and, in some circumstances, it has been shown to be an unpopular method of consuming online news media. Podara et al.'s (2019) study of News usage in the era of Interactive Journalism, indicated that although young people prefer web-based news due to its convenience, speed and cost, this research "showed that all participants preferred online news in the form of text rather than video and audio" (Podara et al., 2019:72). Furthermore, audience engagement studies within the I-Doc field highlight other potential issues. Podara et al. (2021) observed that although many producers do not publish their audience data, analysis of data from 'New Life' (2013), showed that the average viewing duration was three minutes 29 seconds and viewers looked at 3.34 pages on average per session. Ducasse et al.'s (2020) study of 'iOtok' (2018) showed how user engagement dropped significantly during viewer exploration of this serialized interactive documentary.

Therefore, it seems clear that research exploring how journalists can effectively leverage the communicative potential of interactive content, to create I-Doc work that improves engagement, retains viewers and informs users about climate change literacy is crucial to the success of interactive journalism in this field. Cook (2019:281) outlines the problem succinctly, stating: "While there is overwhelming scientific agreement on climate change, the public have become polarized over fundamental questions such as human-caused global warming. Communication strategies to reduce polarization rarely address the underlying cause: ideologically driven misinformation. […] In order to effectively counter online misinformation, we require foundational frameworks that provide comprehensive understanding of the techniques employed in climate misinformation, as well as evidence-based approaches to neutralizing misinforming content." To do this we will analyze and interpret the structures and content of a sample of I-Doc work, before theorizing how evidence-based approaches could be applied within future journalistic work of this kind.

2.0 Literature review

2.1 Interactive documentary, immersive journalism and the pursuit of presence.

Interactive journalism comes in many forms, from the longform transmedia storytelling of slow journalism (Le Masurier, 2016; Renira Rampazzo, 2015), the spherical field of view of virtual reality journalism (Pavlik, 2019) and immersive journalism (de la Peña, 2010; Kukkakorpi & Pantti, 2020), to the Rockstar Games' visual aesthetic and gameplay within documentary video games (Dowling, 2021). Illustrating the multifaceted opportunities created by digital interactive media, and the many theoretical frameworks that can be applied to the analysis of digital journalism. If digital journalism is the production and communication of journalistic content, using digital tools and delivered through digital media. We would argue that it is the *interactivity* that digital technology has enabled, which has stimulated the development of many, overlapping, yet distinct formats. Vazquez-Herrero and Lopez Garcia (2019:3) explain interactivity as "the user's ability to act within the story and also with other users in multiple degrees, from control of the viewing […] and content selection (non-linear access and navigation) to participation (sharing, discussing and contributing)." Therefore, although digital journalism encompasses many types of interactive journalism such as online websites, social media and participatory or transmedia documentaries (Scolari, 2012), we will be focusing on interactive documentary and its intersection with immersive journalism.

One starting point to understand interactive documentary work is the evolution of linear documentaries for delivery online (Gaudenzi, 2013). However, perspectives that foreground the construction of a "non-fiction movie, where the viewer can be given the opportunity of choosing what they want to see and in what order" (Miller, 2004:345), may not fully explore the diverse

nature of current digital content and the changing relationship between media producers and the audience. Vazquez-Herrero and Lopez Garcia (2019:5) comment on the current consolidation of debates surrounding interactive documentary, stating that this fertile area of discourse includes different naming conventions (I-Doc, web-doc, web documentary or interactive documentary), different taxonomies of I-Docs that categorize by technology, interactivity, participation, co-collaboration, and the high hybridization of the format (Sora, 2015). This demonstrates the diversity present in this area, while also illustrating the challenge for scholars to precisely delineate the boundaries of each classification system - especially when applied to the wide range of journalistic formats. One broad definition of interactive documentary which encompasses many aspects of immersive journalism is Gaudenzi's (2013:31) platform agnostic definition which includes "any project that starts with an intention to document the "real", and that does so by using digital interactive technology". However, there are some clear differentiating features, such as the intentionality of the producer and, we would argue, the presentation of the user experience, timeliness of production and distribution.

Theoretical frameworks can be used to explore how these different forms of multimedia journalism use narrative structure or user experience to encourage users to interact with the story. Exemplified by Hernandez and Rue's Triangle Model (2016), their Continuous, Immersive and Comprehensive categories explore: the coverage of a topic without a predefined path through the content (Comprehensive); those which create an immersive environment for the user, where the narrative unfolds organically and there is a high degree of interactivity (Immersive) and those with a linear (Continuous) narrative structure, (Hernandez and Rue, 2016:92-107). One limitation of this model, highlighted by Hernandez and Rue themselves, is the problematic nature of the term 'immersive' being limited to one category, as all narrative exposition will aspire to be immersive (2016:102).

Immersive journalism can be defined as an "emerging form of news reporting that seeks to capitalize on the technological enhancements of virtual environments and Virtual Reality (VR) displays" Hardee (2016:1). The potential of immersive journalism is in the pursuit of presence for the participant, bringing them closer to the story through a more realistic experience which seeks to elicit "a connection between the audience and the news story" de la Peña et al. (2010:292). Although theorizing the impact of interactivity on presence requires an understanding of how we can explore this concept further. Freedman (2005) used the following three-dimensional structure to understand the relationship between media characteristics and users' perception of presence. Presence includes: "a) sense of *Physical Space* – the sense that you are in a contiguous spatial environment; b) *Ecological Validity* the naturalness/realism of the content; and c) *Engagement* - a participant's sense of involvement and interest in the mediated environment" (Villani et al., 2009:38; Freedman, 2005). Hardee and McMahan (2017) include presence, engagement and emotion within their framework for immersion journalism (Fig-1), illustrating

how common immersive technologies such as 360° video, head worn AR (augmented reality) and mobile AR, are being used as tools by journalists to capture and distribute journalistic work. They suggest that where the common types of journalistic reporting and fundamentals of traditional journalism overlap with the common immersive technologies - and the pursuit of immersion - the resulting work can be classified as Immersive Journalism. They define four common modes of immersive journalism; 360° Breaking News, Mobile Immersive Public Service, CG Based Immersive Investigations, and Immersive Explanatory Reports.

[Fig 1 near here]

2.2 Fragmented media, audiences and Climate Change Literacy

There are several issues surrounding I-Docs that relate to the "demands and anxieties raised by its fragmentary nature and its risk of incoherence" (Miles, 2014:68), and although these issues are not unique to interactive documentary, the shift to web based, hypertext enabled, documentary production has not only enabled new modes of authoring journalistic work, but also new practices of reading texts, (Burbules, 1998; Livingstone, 2003). Therefore, scholars such as Podara et al. (2019), have set out to research if interactive reporting is a form of storytelling that is preferred by the post-millennial generation. Indeed, academics recognize that the "challenge in a multi-choice media environment is to find new ways to deliver large amounts of information in a creative and easy way" (Podara et al., 2019:64).

The impact of digital media and networked communication have had a profound effect on audience choice, and this change has not equaled a hegemonic media environment where clear scientific consensus is conveyed effectively to an audience. Climate Literacy/Climate Change Literacy (CCL) fig-2 is a subsection of science literacy which promotes "the advancement of climate change science [with the intention of] laypeople being able to critically analyze media information about climate change and the urgency to address the challenges of climate change" (Azevedo and Marques, 2017:4). Evidence suggests that "skepticism regarding climate change remains strong in some developed countries, particularly in the USA (e.g., Capstick et al., 2015; Schuldt et al., 2011)" and low climate change knowledge remains a consistent issue in the general populace (Azevedo & Marques, 2017). It has also been found by Kahan et al. (2012) that increased levels of education and science literacy can entrench views and increase polarization as "those who are able to handle scientific information are more successful at confirming their own biases and ignoring inconvenient evidence" (Walton et al., 2017; Jones, 2016).

[Fig 2 near here]

Therefore, journalists face a progressively challenging environment, as changing patterns of media use fragment and polarize audiences. Indeed, as media consumption shifts from unidirectional broadcasts, passively consumed by audiences, to more dispersed, globalized, participatory and social forms of media (Livingstone, 2015), audiences are neither guaranteed, nor can they easily be considered as a mass collective. Wilner et al. (2020) found that ideological factors such as political leanings led to distrust of the media and Carmichael, Brulle and Huxter (2017) found a "large and growing divide" in how the issue of climate change was viewed by audiences from different political persuasions. In this environment, if immersive journalism and I-Docs aim to increase Climate Change Literacy *and* reduce the impact of misinformation, there are multiple challenges to overcome. Not only raising Climate Change Literacy within the general populace, but also through challenging the views of narrower sections of climate change skeptics with higher levels of scientific literacy. To achieve these goals, new theoretical frameworks that explore how interactive content can reduce the impact of misinformation (Cook, 2019:281) and increase engagement with climate change content are crucial.

2.3 Interactivity, immersion and narrative structures

To theorize the potential impact of interactive documentary on climate change journalism, we need to differentiate between media form and content. Where "'Media form' refers to the physical, objective properties of a display medium (how an image is represented) and 'Media content' refers to the themes and narrative presented within the medium" (Villani et al., 2009). Furthermore, if constructing a narrative is key in successful documentary work, then influencing a viewer's attitudes and beliefs will partly depend on the construction of the story, the visual stimulus, and the structure in which it is discovered (Hardee and McMahan, 2017; Green and Brock, 2000). Navigation through interactive media can be examined using several theories and metaphors, such as the 'exploding' of a traditional cinematic narrative or imagining the structure as a network of interconnected nodes. The concept of a node is widely used to understand multiple networked phenomena, as it can illustrate the structure in a widely understood visual language. A simple node can be defined as a point in a network (or diagram) where lines intersect or branch. This concept can be expanded to distinguish between different types of 'node' used in interactive media, either by type of event (e.g., a start, goal, ending or death), or the function of the node (e.g., episodes, action spaces or story-worlds), as seen in fig-3 (Ryan, 2015). As you can see from the diversity of structures illustrated in fig-3 and fig-4 (Maurin, 2014), there are multiple design, technological and creative choices needed when constructing a piece of interactive documentary.

[Fig 3 and 4 near here]

When choosing a potential structure for an interactive piece of journalism, the choice between simple or complex structure will influence the levels of engagement, disorientation and ultimately the performance of users (Webster and Ahuja, 2006). The simplest route through a story would be a traditional linear narrative (as seen in fig-4a), whereas a complex navigational design could be a global 'sandbox' navigational design (as seen in fig-3c). Both are simple in certain respects. With one, you can go only one way. With the other, you can go every way. It is the impact of these choices on the user experience that leads scholars to speculate how the structure and navigation influence communicative outcomes. Aufderheide (2015) examined the navigation of I-Docs using three axes: the familiarity of the interface (creating echoes of other media forms); the amount of interactivity (the complexity of options) and the scope of the navigation system (a linear, or complex structure). She suggested that navigation systems are deliberately designed to help viewers flow through the experience, and that detachment from the medium through lack of familiarity with the interface, unclear navigation and user expectations will decrease the efficiency of the message contained within.

Therefore, the network or structure of an interactive project needs to be planned from a very early phase of production, and even elements of gamification can be conceptualized at this point, most obviously in the provision of 'dead-ends' or 'character dies' situations (fig-3d). This planning stage, that Choi (2009) and Bocconi (2006) suggest is the pre-authoring of the design, is not only crucial to the production process, but also creates the template for how users will engage with the project, potentially increasing user familiarity, challenge, or sense of jeopardy within the final project. This design phase should "specify a semantic context that will result in a graph structure of semantic units" (Choi, 2009:45). The amount and arrangement of these semantic units will create (alongside other textual factors) the mood and quality of the interactive experience. For example, even the construction of a simple maze structure, or incorporating a search for information, is a step towards adding an element of user motivation and reward into an interactive project.

2.4 Countering online misinformation using visual and interactive media

Within this landscape, the I-Doc has emerged as an international and experimental form of digital journalism - a subset of other interactive formats which has the potential to be a global standard for quality experimental journalism (Pavlik, 2019). "For journalists, I-Docs represent a compelling story form that can blend excellence in reporting […] with user experience designed to highlight the complexity of many of the world's most vital issues" (Pavlik, 2019:129). This supports the emerging potential of I-Docs to explore complex issues such as climate change, yet further research is needed to explore how this potential can be harnessed to mitigate problematic issues, such as reducing the impact of misinformation and disinformation. Online misinformation can feature several common strategies, from "cherry picking information, distorting data, presenting

fake experts to simple fabrication" (Lewandowsky & Hunter, 2020), but positive research findings have repeatedly shown "if the public knows, ahead of time, what disinformation they are likely to encounter and why it is wrong, they are less likely to accept it as true" (Lewandowsky & Hunter, 2020:online). Additionally, the fields of psychology and information science propose several techniques to counter misinformation and correct the negative impact it may have on society. Research by Lewandowsky et al. (2012) shows that although retraction of misinformation may not fully negate its influence, "warnings at the time of initial exposure to misinformation, repetition of the retraction, and corrections that tell an alternative story that fills the coherence gap" can increase the effectiveness of retractions (Lewandowsky et al., 2012:116). Therefore, journalism and interactive media may need to move beyond simple retraction and move towards creating content that encourages climate change skeptics to engage with alternative material and embedded counter arguments in the interactive content to expose users to corrective, alternative stories.

There is also evidence that visual and interactive means of communication are more effective at countering misinformation than purely textual or passive forms of media consumption. For example, Nyhan & Reifler (2018:123) found that "graphical information is more effective than text in reducing misperceptions", and Roozenbeek & van der Linden (2018) demonstrated that an interactive game where participants learned about misinformation techniques from different perspectives reduced the persuasiveness of similar misinformation. Additionally, 'Inoculation Theory', "a branch of psychological research that adopts the vaccination metaphor" (Cook, 2019), can be embedded in 'active' interactive media and posits that exposing participants to a weak form of misinformation is effective in neutralizing the persuasive arguments against climate change contained within (Lewandowsky & Ecker, 2012; van der Linden, et al., 2017). This technique was also found to increase discussion of the topic, post 'inoculation' (Ivanov et al., 2015), illustrating that the technique helped stimulate viewer debate after engaging with the material.

Furthermore, as the structures, aesthetics and technology exploited by interactive journalism formats become increasingly virtual, computer generated and game-like, greater integration between game mechanics and interactive journalism is predictable. Dowling (2021:1) suggests that the combination of games and journalism has "never been more essential in connecting citizens and providing an alternative mode of civic engagement". Despite friction between the serious and professional nature of journalism and the virtual, imaginary worlds of computer games, gamification can achieve positive outcomes while upholding journalistic standards (Garcia-Ortega, Garcia-Aviles, 2020). Gamification is achieved by "the use of game-based elements and mechanisms in a non-game environment" (Wood & Rierners, 2015). With commonly discussed benefits including increased motivation and engagement (Plas, Homer and Kinzer, 2015).

In summary, decreasing trust in the media (Wilner et al., 2020), a deficit in Climate Change Literacy (Azevedo & Marques, 2017) and the paralyzing impact of climate change disinformation (Treen, Williams, O'Neill, 2020) makes researching effective climate focused journalism essential. Changing audience trends, increased fragmentation within the media and the prevalence of climate change misinformation (Cook, 2019; Painter & Gavin, 2015; Harvey et al., 2018) highlight the positive impact that that new techniques and theories could instigate. Interactive documentary has the potential to include gamification techniques in their pre-authored structures (Choi, 2009; Bocconi, 2006), and visually through their content and navigation functionality.

3.0 Materials and Methods

We will explore how three examples of interactive documentary use different media content and narrative structures to cover environmental topics. Using a content analysis methodology "a technique for gathering and analyzing the content of a text" (Neuman, 1997:272-273), we will extract qualitative and quantitative findings. This article is not an empirical measurement of audience responses to the content and structures presented, but instead offers a comparison of these examples to help infer the intentions of the producers and to highlight areas for further exploration.

Our research questions are:

> RQ1 - What features of I-Doc structures can be identified, and how do they affect journalistic expressions of environmental issues?
>
> RQ2 – Which characteristics of interactive documentary and immersive journalism have the potential to effectively communicate climate journalism or combat climate disinformation?
>
> RQ3 – What are the intersections between I-Docs and the gamification of immersive journalism, and how should they inform future work and scholarly activity?

3.1 Sample selection criteria

To select I-Doc work for analysis, we searched three databases of interactive, non-fiction projects, aiming to select climate change and environmental content by using specific search terms. The databases were MIT's Docubase (https://docubase.mit.edu/), The VR Documentary Encounters' project, (http://www.vrdocumentaryencounters.co.uk/timeline/), and The International

Documentary Film Festival Amsterdam's DocLab project (https://www.doclab.org/category/projects/). These sites listed 403, 603 and 314 titles respectively, although there is some overlap between the respective lists. We approached sampling using a conceptual approach, that suggests that samples can be selected as 'typical' examples of work, which are then compared to different 'discrepant' examples of work (Miles & Huberman, 1994).

The selection criteria were as follows:

1) Classification - the work selected needed to be a web based interactive documentary, using Gaudenzi's 2013 definition.

2) Media format and accessibility - the work selected needed to be freely available to view on a PC/laptop, via an internet browser, without additional accessories (e.g., no VR headset or specialist controller).

3) Relevance of content - the work should cover an environmental/climate change focused topic (e.g., fossil fuel extraction or rising sea levels).

3.2 Coding rules: Identifying interactive elements

As a content analysis should be reliable and replicable for future studies (Krippendorf, 2018), the coding scheme and reliability processes are discussed below. We aimed to record the type and quantity of nodes within the examples, alongside qualitative visual observations. The coding scheme (table-1) builds on the work of Choi (2009) and Gifreu-Castells (2010) to identify super-class and sub-classifications of content within interactive structures. As seen within the work of Ryan (2015) and Maurin (2014), the concept of an interactive network comprised of interconnected nodes is common. By including different classifications of node, our aim is to provide a nuanced analysis of how interactive documentaries are constructed. Gifreu-Castells (2010) explained the different nature of content within an I-Doc stating: "From an analytical perspective, the structure of the interactive multimedia documentary is a hypertextual skeleton made of nodes, links and anchors. What varies is the type of media handled, which range from the purely textual to a mixture of various formats (image, sound, text, etc.)".

[Table 1 near here]

We have suggested that an interactive node (I=interactive node) is a primary (super-class) node, where immersive elements such as the viewpoint can be manipulated, or where there is an environment for the user to explore (Hernandez and Rue, 2016). Other types of nodes display

fewer interactive properties and may be a static or linear presentation of video, audio or documentary content. The secondary (sub-class) elements of an interactive structure are the different types of media content linked to interactive nodes. These elements of the structure contain less interactivity and will either present a linear section of audio-visual content (M=media node), or a document without interactive elements, (D=document node). Gifreu-Castells (2010) found that "The key factor that differentiates the audiovisual from the interactive areas, is the former's linearity, which means that the order of the discourse cannot be changed, while in the interactive area this order can be affected, and even changed." Links (L=link) are parts of the network connecting the nodes together. Anchors (A=anchor) are a simple, visible element on screen that allows the user to click on a word, icon or image that then plays a media clip or moves the user to another location. "This small part, which could be a word, a phrase, a part of an image, is called the anchor of the link" (Gifreu-Castells, 2011; citing Ribas, 2000:37).

3.3 Limitations

It is important to recognise that an I-Doc can be produced and consumed in several ways. Therefore, to make clear the scope of this article, the results relate to the coders' observations of the media content, the themes and narrative structures presented within the examples; rather than the media format, which is the type of display technology used (Villani et al., 2009). Furthermore, as "qualitative content analysis examines the relationship between the text and its likely audience meaning" it is also important to recognize that media texts are polysemic, which means they are open to multiple different readings by different audiences (Macnamara, 2005:4). Indeed, one criticism of researcher-led qualitative analysis of media content is that it relies heavily on time-consuming, subjective, researcher readings, which can lead to smaller sample sizes (Macnamara, 2005). There is clearly some subjectivity regarding what might constitute an interactive node, media clip or document node, and standard elements of online presentation such as basic playback functionality within media players have not been coded.

3.4 Reliability

The primary researcher coded all samples of work and produced graphical representations of the structures. Secondary coding was conducted to test the reliability of the original data. The reliability process helped identify any issues with the coding scheme and the overall agreement between coders was 92.9 percent. Differences in coding were attributed to narrow variances in interpretation that can be used to refine the coding scheme to further improve accuracy.

4.0 Results

4.1 Overall characteristics of sample

a) 'This Is Climate Change: Melting Ice' (2018) was a significant search result on all three databases, met our search criteria for a 'typical' example of interactive documentary work and can be classified as an 'immersive explanatory report' using Hardee and McMahan's (2017) framework for Immersion Journalism. Created by Danfung Dennis and Eric Strauss, it is a short film from a four-part series (Fire, Famine, Feast and Melting Ice) each covering one aspect of climate change. Running at 9'46" in length it features many of the hallmarks of traditional documentary filmmaking, a video format, linear playback, a presenter, narration, general views of the topic and a traditional structure. Presented by former Vice President Al Gore and filmed on location in Greenland, this example is immersive due to the 360° video footage that enables viewers to observe the spectacular landscapes and intriguing interview locations. Its intention is to "take viewers on a transcendent exploration into the devastating consequences of our changing climate" (Within, 2018).

b) 'The Last Generation' (2018) featured within database searches for both 'climate change' and 'ocean' and displayed a different interactive approach to our typical example above. Classified as an interactive web documentary on MIT's Docubase, its position within the interactive journalism space is closer to Godulla and Wolf's (2017) Scrollytelling or Digital Longform Journalism by virtue of its 2D content, delivered within a parallax scrolling website. Parallax scrolling, which is "the technical ability to let some elements stay on a page longer than others as the user scrolls down the page through the story" (Jacobson, Marino & Gutsche, 2016:530). This example is therefore discrepant from a typical example of immersion journalism in Hardee and McMahan's framework, as it does not use one of the common immersive technologies listed. However, it arguably achieves immersion in other ways, such as emotional response or engagement through the skilfully designed audio, video and text content situated within an interactive online space. As Hernandez and Rue (2016) point out, all narrative exposition will aspire to be immersive in some respects. Produced by Katie Worth and Michelle Mizner this multimedia experience has received several journalism awards for its visual digital storytelling.

c) 'Offshore' (2013) was selected as an example of an interactive documentary which displays elements of documentary video games. Also classified as a 'Computer Graphics (CG) based immersive investigation' using Hardee and McMahan's framework, this example displays how I-Docs and gaming can intersect. Pavlik suggests that "I-Docs are typically built around a visual frame - often using a panoramic image as an interactive user interface - and video as a central component" (Pavlik, 2019:129). Here the visual frames

that construct each node of the experience are 'virtual' i.e. computer-generated replicas of vehicles and locations, but video is also a central component of the documentary material. Produced by Brenda Longfellow & Glen Richards in conjunction with Helios Labs, its link to climate change is not as explicit as the first two examples, and interestingly only featured in one of the databases. However, its computer-generated, interactive exploration of an oil rig presents a cautionary tale about the risks and environmental impact of our continued reliance on fossil fuels. "Using a virtual Offshore rig, the Spartan 208, as the central interface, viewers are invited on a first-person journey through a nightmarish abandoned rig, damaged and deserted save for a series of 'hotspots' transition points - which propel participants into the full screen world of oil, technology, money and environmental disasters" (Offshore Guide, n.d.). This impressive, computer generated, virtual environment is supported by 71 minutes of video content, atmospheric audio, redacted documents, and maps.

4.1 Offshore: visual observations and a summary of quantitative findings

Offshore presents a computer game-like immersive experience, with visuals and navigation reminiscent of a first-person shooter (FPS) game. From the introductory video prologue, it creates a dark visual environment where the colours, audio and 360° locations combine to generate an ominous atmosphere. The environment will be visually familiar to gamers but is substantially different to traditional news sites and conventional reporting of environmental issues. There is no scrolling through text or images, the visual interface is clearly point of view (POV), and interactive elements are hidden behind subtly situated links, intentionally arranged to be found organically. The illustration of the structure in fig-5 shows the complexity of this interactive structure. The video prologue (node 2), arrival on the rig via helicopter (3) and the introductory audio and documentary content (4, and 5) are arranged in a way that allow the user to feel like they are observing this event first-hand.

The nodes that we have classified as interactive (1,3, 6, 9 ,13, 15, 19, 23, 25-27, 32 & 48), act not only as a virtual location for anchors and links to be situated, but users can also look around the 360° locations providing a sense of physical location, one component of presence (Villani et al., 2009; Freedman, 2005). The nodes also act as a hub for the media content that the user can find and consume in any order. The exceptions to this are the site map (48), which only contains eight links to the other locations of the rig, and a tablet-style media player (26), which does not have 360° functionality, but is interactive and part of the story-world. Interestingly, the media content nodes (2, 5, 7, 8, 10-12, 14, 16, 18, 22, 24, 28-31, 33, 34 ,36, 37 & 40-47) can generally be divided into two modes of delivery: those which are displayed within a full screen, pop-up video player (which is visually distinct from the industrial design of the rig) and those that play within the

virtual story-world, notably the video sequences linked to the submersible (40-43), tablet (40-47) and control room (34). This in situ video playback, is similar to embedded in-game information displays that feature in modern computer games. Adding to the ecological validity (realism), that underpins the game-like aesthetic of this example.

The document nodes (4, 17, 20, 21, 35, 38 & 39) also have similar visual and content differences. Some are designed to maintain the visual feel of an offshore industrial operation. These documents appear to be original, in situ, primary sources (4, 17, 21, 35), complete with coffee cup stains, annotation and redaction. They are designed to look and 'feel' (as much as an on-screen digital reproduction can) as if you are seeing the primary sources of information first-hand. Others (38, 39) are more like basic web pages and include links to outside news sites, such as the Tampa Bay Times.

The spatial distribution of nodes within this documentary (fig-5), reveals several properties that may influence the potential of this example to engage audiences. Firstly, this structure is the most complex in terms of the interconnectivity between nodes and the amount of links per node. When compared to the theoretical diagrams of Maurin (2014) and Ryan (2015), there is some interpretation needed to establish if this structure is closest to a maze, a concentric network, an action space, or a combination of these structures. The average amount of links per node is 1.8 (Table-2), however this incorporates media nodes that generally do not link anywhere else. A better illustration of the complex interconnectivity comes from the average number of links that are accessible from the 13 interactive nodes (n=6.6). This figure illustrates that from each 360° location, the viewer can not only interact with the virtual location, but have on average, six links to media content, or links to other interactive nodes. In this regard, each interactive node is behaving as an individual 'story-world' or 'action space' (Ryan, 2015), where the viewer can observe and interact with the content presented. This realization, alongside the high number of links to media (60% of all links are to media content), demonstrates that a viewer of this documentary has the greatest opportunity to explore, experience media content, get lost and revisit interactive nodes in the order of their choosing. There is no clear ending, so the maze-like structure leads to further comparisons to 'sandbox' computer games.

4.2 The Last Generation: visual observations and a summary of quantitative findings

'The Last Generation: Climate Change and the Marshall Islands' has the look and feel of a longform journalism piece, with smooth parallax-style scrolling and seamless integration of 2D video content, images, text and graphics. It presents an interactive, multi-stranded structure to the viewer (fig-6), with each strand giving a different characters' perspective on the influence of climate change and geopolitical events on inhabitants of this at-risk archipelago. As user navigation through the material is primarily controlled by scrolling, without the constant

punctuation of links and anchors (except an ever-present link to the character selection page), the content flows smoothly between different elements. However, one result of this was that nodes appeared shorter in duration and were more difficult to identify and code. We identified different nodes by looking for continuous visual similarities (such as a continuous background image), which remained constant even if other elements changed through parallax scrolling.

The scrolling interface was familiar and replicated the typical online interaction a user might have with a traditional website. The presence of navigation aids - such as a progress counter and the ever-present return to the introduction/character selection screen - was reassuring and introduced visual confirmation of user progress, and the time needed to complete a narrative arc. These reassuring and familiar features are in direct comparison to the more game-like and unfamiliar navigational experience within 'Offshore'. This simplicity can be interpreted as a strength of this form of interactive journalism, as the linear narrative and familiar longform, digital storytelling creates an artefact that not only has journalistic pedigree, but also delivers media content in an accessible, scrolling, web-enabled interface that removes many barriers for new audiences.

This example is consistently interactive and visually appealing, with audio visual content being triggered by minimal user interaction. The interactive nodes (1, 3, 5 ,7 ,9 etc.) are interlaced (braided) with video clips (2, 4, 6, 8 etc.) creating a seamless, incremental progression through the narratives. Instead of the rather dramatic, moody transitions between virtual locations in 'Offshore', here the emphasis is on smooth, subtle web design. The linear build up to the character selection screen (node 10) is reminiscent of the introduction to a broadcast documentary. The changing visuals, text and animation content is introduced gradually with every scroll, while atmospheric natural sounds and emotional music immerse the viewer in the documentary material.

The structure shown in fig-6 illustrates the multiple directional branches allowing the user to progress down different narrative routes. Each character's story arc progresses in a linear order, intentionally structured by the creators to introduce their situation, highlight their motivations and provide some resolution, even if some questions remain unanswered. There are limited decisions to view documents at specific nodes (10, 14, 18, 26 etc.), and although there are several end points at the end of each character's journey (29, 51, 73), in this example the viewer may loop back to the character selection screen to experience a different character arc. Therefore, elements of jeopardy and risk come from the content of the media interviews and the climate change data presented, not through the overt gamification of the interactive structure.

We found that this example recorded smaller amounts of interactivity per node, with on average 1.6 links per node (Table-3). This figure was inflated by the ever-present return to the character

selection link. The smooth assemblage of multimedia content resulted in the greatest number of interactive nodes (n=33) and a similar amount of media nodes (n=27). This was due to the braiding of interactive nodes and video clips, which were punctuated intermittently by textual information or photographic images (15, 19, 22, 27, 37, 39, 41, 44 etc.). Overall, the interactivity here is attributable to the dialogic relationship between the user and the web interface. The viewer needs to interact almost constantly with the artefact to reveal new information, the exception being when a media node is triggered, then the viewer may passively watch the clip.

4.3 Melting Ice: A Climate Change Story - visual observations and a summary of quantitative findings

This example provides a series of linked 360° video scenes which create a linear, yet immersive experience. Featuring remote Greenland locations, voice over and expert interviews, we recorded no on-screen links/anchors, therefore the interactivity is provided by the viewer controlling the direction the visuals within the 360° video locations. The creators provide a single, route through the narrative structure, with each 360° scene showing a different element: the titles (1), helicopter arrival (2), interview (3), landscapes (4) and so on. The linear playback of these video clips suggests that they could be classified as media nodes. However, Gifreu-Castells' (2010) interpretation of media clips as linear objects does not apply when immersive 360° video enables both linear play-back and interactivity in term of your field of view. This example is distinct from the other samples in that when the playback starts, even though you are immediately immersed in the visual content, there is a temptation to set your preferred viewpoint and watch the material in a passive, traditional way.

If in 'Offshore' or 'The Last Generation' you do not engage with the links or scrolling function, you will not progress through the structure. Here, there is no inbuilt mechanism that makes viewer interaction essential. Although you can change your field of view at any time, the default framing and the seamless playback of the content means that interaction with the immersive element is optional. We recorded 11 nodes within this documentary, that smoothly link together through simple video editing transitions rather than using clickable anchors (n=0), or links (n=0). This gives 'Melting Ice' a visual consistency that provides a strong level of familiarity with traditional documentary media. Arguably, without additional technology (e.g., a head worn display-HWD), this familiarity provides a high degree of orientation within the structure, leaving the user free to concentrate on the visuals, interview, and narration, rather than debating in which direction to travel next. Additionally, the ability to look around the locations freely, without visual distractions on screen, provides an element of control which may encourage the viewer to feel more present.

The structure (fig-7) and content presented within this example is again distinct from 'Offshore' and 'The Last Generation'. This example features one main narrative arc, where the interview and narration are organized efficiently to deliver a clear message about climate change. This interactive documentary does not have the emotive character strands that feature in 'The Last Generation' or the maze-like structure of 'Offshore', however it is a good example of how Hardee and McMahan's (2017) immersion journalism framework can incorporate linear 360° filmmaking.

5.0 Discussion

5.1 Controlling the narrative, "lean-forward" or "lean-back"

The filmic, linear structure of 'Melting Ice', allows the author control over the narrative and the order of the content. Documentary storytelling in a classic linear form suppresses variation in the narrative experienced by the user and allows the journalist to guide the viewer to a predetermined conclusion (Nichols, 1987). In 'Climate Change Melting Ice' the authors control the pace and delivery of the information, relying on the immersive potential of the 360° video medium to engage users. If the goal of immersive journalism is to create a sense of presence for the user, then the combination of filming format and display technologies may create the deep immersive journalism that is required to make audiences feel as if they are actually there (Hardee and McMahan, 2017; de la Peña et al., 2010). Although the risk is that without an element of active audience interaction, users may lapse into passive modes of viewing (RQ1). The combination of linear narrative exposition, the use of multiple audio/visual media and the I-Doc design elements contributes to an intersectional Continuous/Immersive classification (Hernandez and Rue, 2016). This enables a journalist to control the narrative exposition, but still engage users with the dialogic relationship between the environmental material and active engagement with the content (RQ1).

'Offshore' has the most flexible 'global' navigable structure, which is shown by the highest number of average links and anchors per node. The majority of the navigation and media playback within this example is activated by clickable anchors. This provides a high degree of user control, but also slows down navigation and the design risks users becoming disengaged through inactivity, this could explain the high user attrition rate found by Ducasse et al. (2020) (RQ1). Scrollytelling has been cited as being superior to clicking, as it is less disruptive and natural for the user (Bostock, 2014; Hernandez and Rue, 2016). However, it is arguable that encouraging user engagement and emotional involvement with the content is of greater importance. How to

encourage active “lean-forward” interaction with environmental content rather than more passive “lean-back” modes of consumption is one area for further exploration (Hernandez and Rue, 2016) (RQ3). In ‘Offshore’ users need to ‘work’ to find some of the media content, adding elements of realism, exploration and satisfaction to the experience. The arrival sequence (video prologue) and the subtle layout of media content provides an element of gamification, challenge and roleplay. The user is allured to navigate through this content by the enigma presented by the structure (RQ2). Upon ‘landing’ on the platform the user will have some basic questions regarding the information and navigational design (or lack of) they are presented with. What awaits within this location? Why is the platform deserted? What do I (the viewer) need to do, and why?

The arrangement of content here provides agency and motivation to users. Locations feel like levels to be completed, and clicking on an anchor, may trigger an animation sequence that introduces the next ‘level’ or media node. Perhaps the creators have taken inspiration from the cut scenes common in computer games. Elements that are missing to further gamify this documentary are a reward system (potentially key information goals), character selection (to enhance user personalization) and an element of risk appropriate to the different locations. For example, the simple inclusion of a countdown timer could increase motivation exponentially, although this needs to be tested empirically (RQ2, RQ3).

This example demonstrates the potential of gamification within climate change journalism and suggests key areas for further exploration. If creators have the desire and technological skills to create interactive designs that engage and motivate users, the possibilities to embed targeted challenges, create space for teamwork and even create voice discussion between ‘players’ are all conceivable (RQ3). However, production time and the technological constraints of creators and audiences must be considered. Vazquez-Herrero and Lopez Garcia (2019) noted that although interactivity promotes new author-text relationships, it also introduces new risks, including economic barriers, different user motivations and aspects relating to the digital divide such as familiarity with different platforms. Podara et al.’s research (2019, 2021) illustrates that interactive formats are not automatically preferred by audiences, therefore future studies would need to consider technological and situational factors such as platform of consumption and audience viewing situation (RQ3).

The scrolling, linear navigation of ‘The Last Generation’ (fig-6) is reassuringly familiar to users who may commonly consume online news. Aufderheide’s (2015) axes of user navigation, discuss how a simple interface can reassure users and reduce disorientation. The ‘braiding’ incorporated within this I-Doc “where two or more media appear together to create a combined meaning” (Jacobson, Marino & Gutsche, 2016:531), make this interactive story accessible to viewers of television and consumers of online journalism content. Indeed, different audience demographics may be engaged by this association with familiar media products. Manovich (2002) suggests that

the inherent language of visual cultural formats (such as interactive work) will largely be understood by the viewer through their familiarity with, and existing knowledge of, other already familiar, cultural forms. Therefore, while it is highly conceivable that the accessible and familiar interaction of 'The Last Generation' could be an effective technique to engage users with climate change content (RQ1). This outcome will not suit all I-Doc formats, as audience familiarity with their design, technology and navigation is not guaranteed.

5.2 Exploiting the benefits of multi-stranded narratives.

The results show the dramatic range of interactive structures and types of immersive content recorded within these examples. The differences in the temporal and spatial organization of the interactive nodes, links, media content and documents highlight the diversity in interactive approaches within I-Docs and Immersive Journalism. We suggest that through their planning, media acquisition and design phase (Choi, 2009; Bocconi, 2006), the creators have had a powerful influence on how these examples communicate the environmental content to an audience. Perhaps the clearest difference is shown by a comparison and analysis of the narrative structures used. These vary from 'Offshore's maze-like 'action space' network (fig3-i) that displays clear indicators of gamification in the navigational challenge it presents to users (RQ3). Here, the immersive environment, organic narrative and high degree of interactivity contributes to an Immersive classification according to Hernandez and Rue's triangle model (2016).

The multi-stranded structure of 'The Last Generation' is similar, although not identical to, the branching structures devised by Ryan (fig-3b) and Maurin (fig-4d). In this example, the three-character strands each display properties of linear narratives. However, the creators have also leveraged the interoperability of these structures to use side branches (fig-3a), include additional documentary information and enable multiple character strands to allow different viewpoints to be told independently of each other. This has several advantages for climate change journalists, as it allows information to be explored in detail, enables the inclusion of supporting statistical evidence and promotes balance by allowing multiple viewpoints to be recognised within the same piece (RQ1, RQ2).

Podara et al. (2019) found that young people preferred web-based news due to its convenience, speed and cost, and 'The Last Generation' is certainly accessible in this regard. However, in the battle for users' attention (Ducasse et al., 2020) can makers of interactive documentary exploit multi-stranded narrative techniques to increase audience engagement? We suggest that to fully harness the potential that interactive media presents, climate change journalism should embrace the opportunity to allow viewers to take on different roles (RQ2). Each example here presents climate change and environmental content in a different interactive format and structure, but if

users' motivations to consume the content are wedded to the "lean-back" viewing of a traditional documentary, then their participation could still be essentially passive.

We can infer that the creators of 'The Last Generation' intended to create an immersive experience for the audience by creating emotional engagement with the characters presented within the media content (primarily interviews). Using three-character driven narratives within a multi-stranded structure, helps engage users with their stories and encourages a sense of presence through the atmospheric sounds and visuals. This is therefore a *character* driven I-Doc, which can exploit the multi stranded potential of a branching structure to appeal to different audiences. Theoretically delivering environmental content more effectively to an engaged audience (RQ2).

This engagement could be further enhanced, or specific audience groups could be targeted by purposefully embedding characters that would attract users with conflicting viewpoints, potentially introducing characters from different age groups, job roles or backgrounds. Journalists could use this technique to reduce the impact of climate misinformation, by highlighting common climate change misinformation tactics using certain targeted characters, creating traditional dramatic conflict, engaging audiences, before providing a resolution through evidence-based information that counters incorrect viewpoints. The tailoring of the experience to individual users is one potential advantage of interactive structures. As users are directed into choosing their preferred characters, journalists can use this information to provide key information tailored to users' choices (RQ2). This 'responsive journalism' where information can be released to users according to their navigational choices, could be designed into the content permanently or programmed to respond to different choices.

5.3 User autonomy, gamification and inoculation

An intriguing observation regarding these examples is that although the creators of 'The Last Generation' and 'Melting Ice' both control the linear order of the media content, only viewers of 'The Last Generation' can follow specific characters from the beginning to the end of their narratives. Viewers easily view their linear narratives through the familiar web interface, observing the story from a distance. However, 'Offshore' and 'Melting Ice' (to a very limited degree) attempt to replicate a more autonomous experience offering the user the ability to control their visual viewpoint and in the case of 'Offshore' provide some autonomy to explore. This places the user within the location of the I-Doc, involving them to some extent in the discovery of the narrative - creating a user driven narrative structure. In 'Offshore' specifically, the visuals and the interactivity position the user closer to being a protagonist that a viewer, allowing them the autonomy to explore the location and discover pieces of media content (RQ3).

This is clear evidence of the gamification of 'Offshore' and illustrates how I-Doc structures and visual content can imitate the visual language and dynamics of games (RQ3). This observation is supported by the lack of consistent characters within 'Offshore', as the user is not watching a linear narrative from a distance, the user is piecing the information together from multiple characters within the media presented in different locations. This distinction between linear-narrative driven I-Docs and user-protagonist I-Docs could be used to test the comparative effectiveness of immersive journalism to communicate climate change information in future studies (RQ3).

Additionally, other gamification techniques could be explored to increase the effectiveness of environmental communication within I-Doc work. For example, providing goals or challenges for the 'viewer' could add new levels of engagement to the user experience. Our argument is: if a viewer has the autonomy to look around an environment, would it not be beneficial to provide a specific reason for them to do so? Within 'Climate Change: Melting Ice', asking questions of the audience, or setting challenges that encourage a search for information, could act as a powerful climate literacy and engagement tool (RQ2), directing viewers towards certain information. Another option would be to employ a common misinformation tactic at the beginning of the documentary, then embedding specific information that counters this argument within the narrative, increasing audience resistance to climate change misinformation. Especially if this knowledge was signposted at the beginning and tested at the end. This simple gamification of linear and immersive journalism formats would align with inoculation techniques and potentially reduce the impact of climate change misinformation (Basol, Roozenbeek & van der Linden (2020); Lewandowsky& Hunter (2020); and Cook, Lewandowsky & Ecker (2017) (RQ2, RQ3).

Interactive inoculation methods with active participation in the process (e.g., a game) were found to have increased efficacy, allowing better identification of misleading information (Roozenbeek & van der Linden, 2018). Rajanen & Rajanen (2019:254) suggest that gamification has the "potential to engage individuals and various stakeholders" to promote climate change literacy "through interactive, participatory and meaning-making communication." What is needed is journalistic design that gives users a sense of empowerment, and triggers agency, whilst also maintaining journalistic principles and ethics. This paradigm shift from passive communication techniques to 'communication through interaction' could create new active approaches to increasing climate change literacy through gamification, (Rajanen & Rajanen 2019:254; Ballantyne 2016). From the earliest stages of design, authors need to consider not just the technical format, structure and narrative of interactive content, but increasingly incentives,

challenges and goals to encourage the viewer to navigate through the material and engage with active journalism communication (RQ3).

5.4 Climate Change Literacy and the battle for attention

Multiple areas need to be addressed if I-Docs wish to thrive among the battle for attention (Ducasse et al., 2020) within fragmented digital audiences (Podara et al., 2021). To increase levels of climate literacy and awareness of environmental issues, journalists need to test for the most effective interactive structures that firstly engage with target audiences, but also help achieve their climate literacy goals. One of the challenges facing journalistic web documentaries is that many new audiences expect, even prefer, to consume digital media on demand, on the go and formatted for mobile consumption. As Vazquez-Herrero and Lopez Garcia (2019) point out, the development of new formats in online media can be linked not only to innovation by the authors, but crucially, it is in response to changing audience demands. Audiences who are now frequently able to "interact, play and share in an environment favored by mobile communication[s]" (2019:1).

This suggests that engaging interactive journalism may need to be formatted for mobile, be shareable, and engage users with challenges or emotional content which will compete with more accessible social media platforms (RQ1, RQ2). Secondly, techniques to help viewers critically analyze media information about climate change need to be developed, such as tools to resist climate change misinformation. One overarching aim of increasing information discernment within audiences is promoting proactive skepticism. This is the ability to "make independent judgements on the validity of information by, for instance, assessing the legitimacy of the source" (Walton et al., 2018:307). Therefore, immersive journalism that promotes proactive skepticism through visual and interactive techniques could be used to both increase climate change literacy and 'inoculate' users about 'fake news' (RQ2).

Objectivity and 'fairness' are core aspects of journalistic practice, although balance - or what critics might call 'false equivalence' - has been a problematic issue for journalists in recent years (Mutsvairo 2016; Spayd 2016), causing some journalists to wrestle with balance and impartiality when evidence points heavily in a particular direction. There are additional factors in play here, such as national, individual or organizational bias (Brüggemann & Engesser, 2017). Potentially, inoculation techniques provide journalists with a strong rationale to present different sides of an argument, but also maintain their goals of ethical, autonomous, and public service coverage (Hardee & McMahan, 2017). It has been suggested that inoculation theory may be more effective with younger target groups because they "are still developing their beliefs about the world and have less crystallized attitudes and opinions" (Roozenbeek & van de Linden, 2018:7). Therefore,

the combination of gamification and inoculation theory could be an effective way of educating groups about climate literacy and to protect against misinformation techniques later in life.

Finally, strategies that include appropriate content to engage fragmented audiences by harnessing the potential of multi-character narratives could help increase the efficacy of climate change journalism (RQ2). Recent articles by Basol, Roozenbeek & van der Linden (2020); Lewandowsky& Hunter (2020); and Cook, Lewandowsky & Ecker (2017), suggest that inoculation against misinformation and disinformation (Treen, Williams, O'Neill, 2020) is an effective method of reducing the distorting influence of online disinformation strategies. Incorporating these techniques within the gamified, multi-stranded structures of I-Docs could provide the ideal system for communicating different sides of an argument in a responsible way. It appears clear from this study that interactive journalism products have the potential and technical capabilities to present the key elements of an inoculation message: (1) an explicit warning of the threat and (2) a counter argument that exposes the disinformation (Cook, Lewandowsky & Ecker, 2017). Furthermore, this technique can also be used in conjunction with gamification, as active participation in inoculation games is effective in increasing people's ability to spot misinformation techniques (Basol, Roozenbeek & van der Linden, 2020). (RQ2, RQ3).

6.0 Conclusion

One conclusion we can draw from the overlapping definitions of interactive documentary, immersive journalism and digital journalism is that the boundaries between what is considered digital journalism and other forms of interactive non-fiction are blurring (Vazquez-Herrero and Lopez Garcia (2019:2). This can be attributed to the ubiquity of the web as a delivery medium, convergent approaches to digital journalism and the need to innovate storytelling practices to compete with other media platforms. Indeed, it is the exploration of the most effective ways to compete for audiences' attention that makes further research in this area important.

Studies by (Podara et al., 2019; Ducasse et al., 2020; & Podara et al., 2021) illustrate the audience engagement challenges that face the creators of interactive documentaries, and this article illustrates the large variation in the visual themes, media and structures used in climate change focused I-Docs. However, there is still considerable scope for scholarly activity that quantitatively assesses how different interactive structures impact viewer responses. For example, empirically investigating how inoculation techniques or gamification frameworks can be applied to interactive content. Further research in this area should aim to determine if a statistically significant correlation can be established between a) gamification and increased engagement with interactive content, or b) inoculation techniques and increased information discernment regarding climate change misinformation.

Our findings demonstrate that interactive documentary structures and their component elements (media, links, nodes) can be identified, codified, and quantified, and that this process has helped determine how

elements of gamification can be identified within climate change focused I-Docs. One potential benefit of the gamification of Climate Change content is that it can change the audiences' relationship with immersive media. Changing viewers from passive 'lean-back' participants in the I-Doc story world, to active participants, seeking out information and potentially using it for a defined purpose. Embedding gamification and inoculation techniques within I-Doc practice is both an exciting and challenging area for future exploration. If a correlation can be established between the use of inoculation theory techniques within gamified I-Docs, and a test audiences' ability to identify and reject climate change misinformation, the benefits for journalists to increase Climate Change Literacy through interactive and immersive journalism could be tangible.

Analysis of this sample illustrates that interactive documentaries conform to recognizable, although diverse interactive structures - such as those identified by Maurin (2014) and Ryan (2015) - yet also present journalistic content in remarkably different ways. The structures and audio-visual elements are assembled in ways that consciously influence the mood and familiarity of the interactive experience, engaging and motivating viewers in different ways. We would argue that how the content is designed, arranged or 'gamified' alters its communicative potential, by creating familiarity with other media forms, such as with 'Climate Change: Melting Ice', stimulating engagement by presenting a familiar journalistic experience. Or, by facilitating user motivation, through a more enigmatic, game-like, user experience, such as the first-person interface presented within 'Offshore'.

It appears clear from this study that interactive journalism products have the technical capabilities to present the key elements of an inoculation message: (1) the explicit warning of the threat and (2) a counter argument that exposes the disinformation (Cook, Lewandowsky & Ecker, 2017). Furthermore, this technique can also be used in conjunction with gamification, as active participation in inoculation games is effective in increasing people's ability to spot misinformation techniques (Basol, Roozenbeek & van der Linden, 2020). Indeed, regardless of the outcome of future studies, the findings of this article can be used to refine current practice. As these techniques highlight the importance of the design phase for interactive journalists. Viewer engagement, gamification techniques and interactive structures should be considered at the earliest stages of planning, allowing creators to harness the emotive potential of multi-stranded narratives or the motivational potential of gamification.

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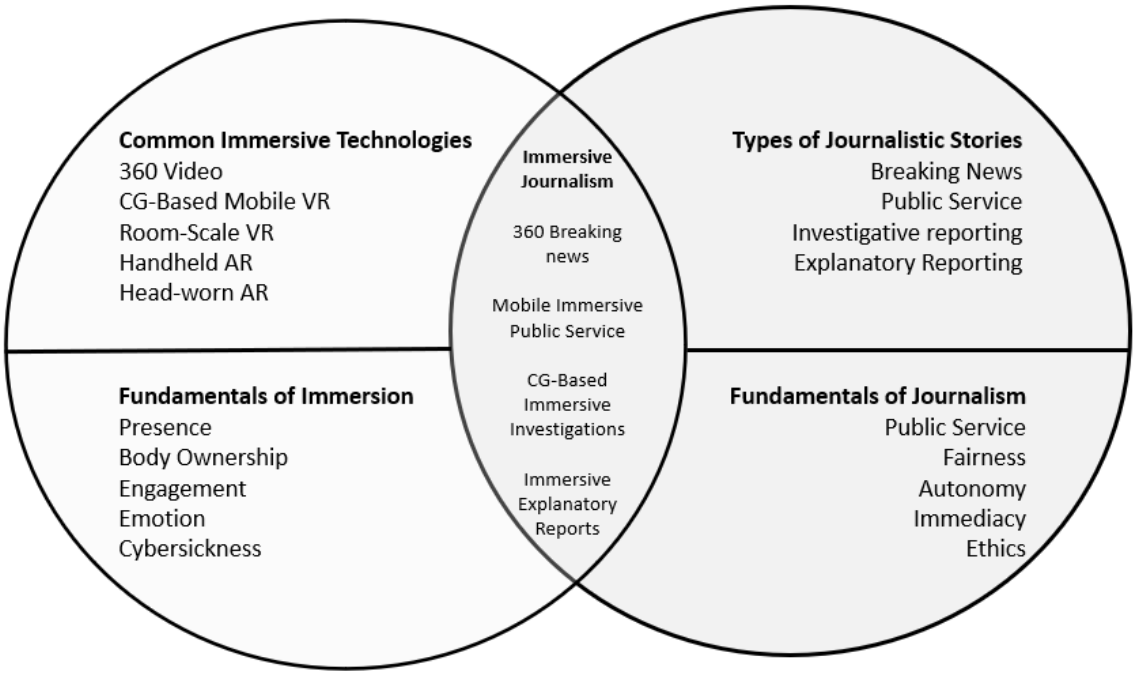
Supporting Document - Figures, Tables and Results

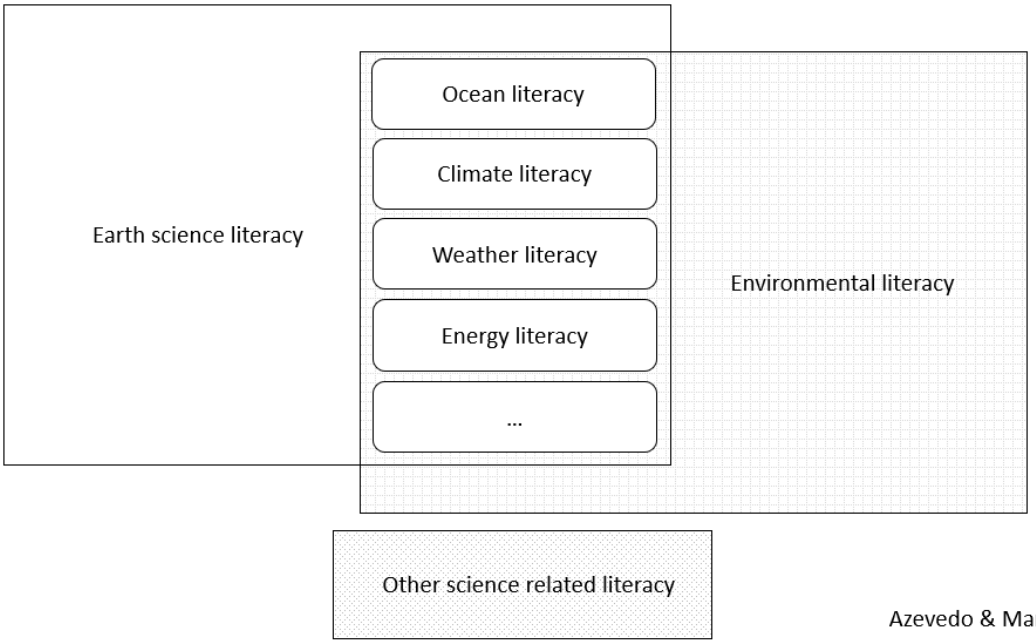
2.0 Literature Review images

Fig-1 Hardee and McMahan's Framework for Immersion-Journalism



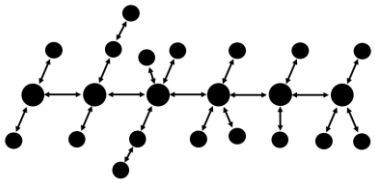
Hardee and McMahan (2017)

Fig-2 A visual representation of the interrelation and scope of several science-related literacy concepts.

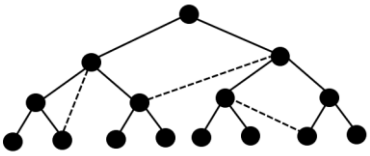


Azevedo & Marques (2017)

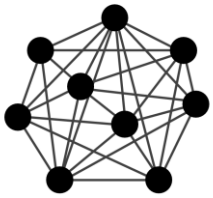
Fig-3 Interactive structures according to Ryan (2015:166-176)



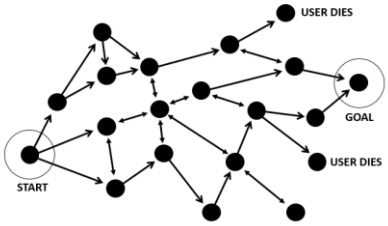
a) Vector with side branches



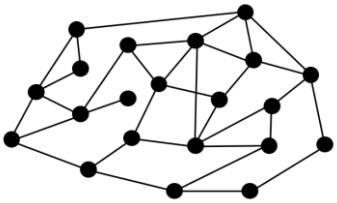
b) The Tree



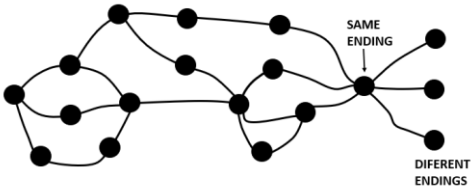
c) The Complete Graph



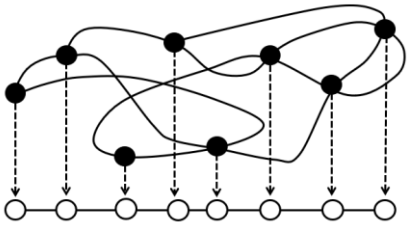
d) The Maze



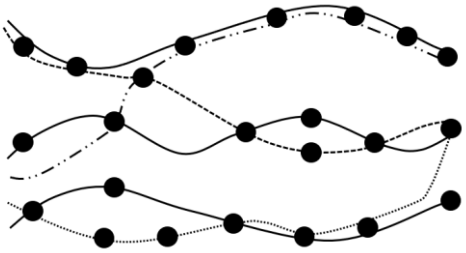
e) The Network



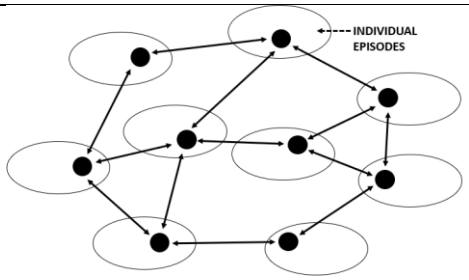
f) The Directed Network



g) The Hidden Story



h) The Braided Plot



i) The Action Space / individual storyworld

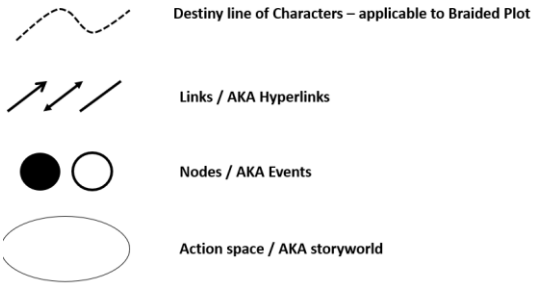
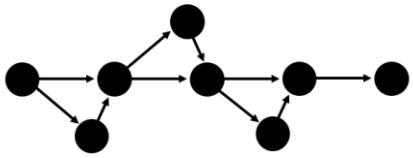
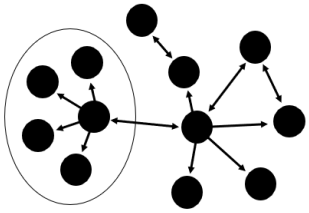


Fig-4 Interactive structures according to Maurin (2014)

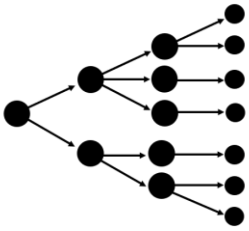
a) Linear



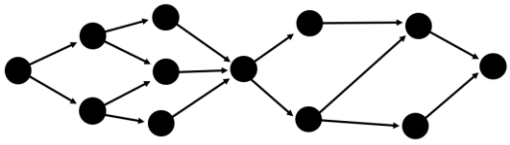
b) Fishbone



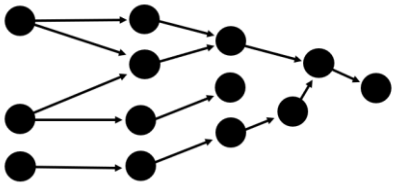
c) Concentric



d) Branching



e) The Parallel Narrative



f) The Threaded Network

3.0 Materials and Methods

Table 1 – Classifying different elements of an interactive documentary network.

Gifreu-Castells' (2010) classification of I-Doc elements	Our sub classification	Working definition applied in this research
Nodes	Interactive node (I)	Interactive nodes enable you to manipulate what you see (or hear) beyond the play/pause interaction of a linear media clip. You may be able to look around a 360°-video landscape or choose your direction from different options. The three types of interactive node are: • Responsive changing content: a node where the background environment remains the same, but you can alter elements within that environment, (clicks or scrolls may change the text or sound within that environment). • Decision nodes: a node where you need to choose your next location. • Immersive 360 video: a node where you can look around the environment using a head worn display, computer or mobile device. Interactive nodes may combine several of the characteristics above.
	Media Node (M)	A linear presentation of media content (audio/video), that you can only play, pause, skip, exit or influence volume
	Document Node (D)	A document node presents static journalistic content on a web page, photograph, or other online medium. You may be able to cycle through the static documents you see (e.g. turn a page, or click to the next document), but these options must not change the information within the document.
Links	Link (L)	Links connect elements together, they can be clickable hyperlinks that move users to a new location, but they can also activate the playback of media content within a node within a media player or as part of a virtual environment.
Anchors	Anchor (A)	An onscreen hyperlink to a different node or element of content. If your online cursor highlights an actionable/clickable element, this is an anchor. Other forms of movement are possible without anchors, such as using a keyboard, cursor keys or scroll wheel.
Assumptions 1) Nodes may be visually different and connected in different ways, especially within these divergent samples. 2) For the purposes of coding, all elements that are triggered from within a node have been coded as linking to that node. 3) Basic playback/web functionality has not been coded. 4) When navigating an interactive product, multiple input devices can be utilized, therefore we have considered the scroll/swipe function on a similar level to clicks from a keyboard and mouse.		

4.0 Results

Table 2- Quantitative results: Offshore

Node No	Node Type			Description	Links per node	Anchor points On screen
	I	M	D			
1	1			Computer generated 360 seascape	1	1
2		1		Prologue video sequence	0	0
3	1			Computer generated 360 helicopter	3	4
4			1	Document in helicopter	0	0
5		1		Audio clip - welcome	0	0
6	1			Computer generated 360 landing pad	5	5
7		1		Video sequence – a dangerous frontier	0	0
8		1		Audio clip - offshore	0	0
9	1			Computer generated 360 lower deck	6	6
10		1		Audio clip – estimated reserves	0	0
11		1		Video sequence – Deep to ultra-deep	0	0
12		1		Computer generated animation	1	2
13	1			Computer generated 360 boat	6	6
14		1		Computer generated animation (pre-Terminus)	1	2
15	1			Computer generated 360 Terminus	7	7
16		1		Video sequence – The well from Hell	0	0
17			1	Documents of survivors	0	0
18		1		Computer generated animated (pre-theatre)	1	2
19	1			Computer generated 360 Theatre	6	6
20			1	Diary	0	0
21			1	Map	0	1
22		1		Video sequence – BP -The Gulf is Alright	0	0
23	1			Computer generated 360 - Sub hangar	5	5
24		1		Video sequence (Sub hangar) - On the water	0	0
25	1			Computer generated 360 – Submersible	6	6
26	1			Tablet style video player	4	4
27	1			Computer generated 360 – Chemical storage	6	6
28		1		Video sequence - A Deadly Dispersant	0	0
29		1		Video sequence - A Public Health Crisis	0	0
30		1		Video sequence - Engine Room	0	0
31		1		Video sequence - In The Bloodstream	0	0
32	1			Computer generated 360 Control Room	6	6

33		1		Video sequence - Extreme Oil	0	0
34		1		Video sequence – stock market	0	0
35			1	Document - (field data)	0	0
36		1		Audio clip (boat)	0	0
37		1		Video sequence (boat)	0	0
38			1	Document with web link	1	1
39			1	Document with web link	1	1
40		1		Video sequence (sub)	3	4
41		1		Video sequence (sub)	3	4
42		1		Video sequence (sub)	3	4
43		1		Video sequence (sub)	3	4
44		1		Video sequence (tablet)	0	0
45		1		Video sequence (tablet)	0	0
46		1		Video sequence (tablet)	0	0
47		1		Video sequence (tablet)	0	0
48	1			Site Map	8	8
TOTALS	**13**	**28**	**7**		**86**	**95**

Fig 5: An illustration of the structure of the non-fiction multimedia narrative, Offshore

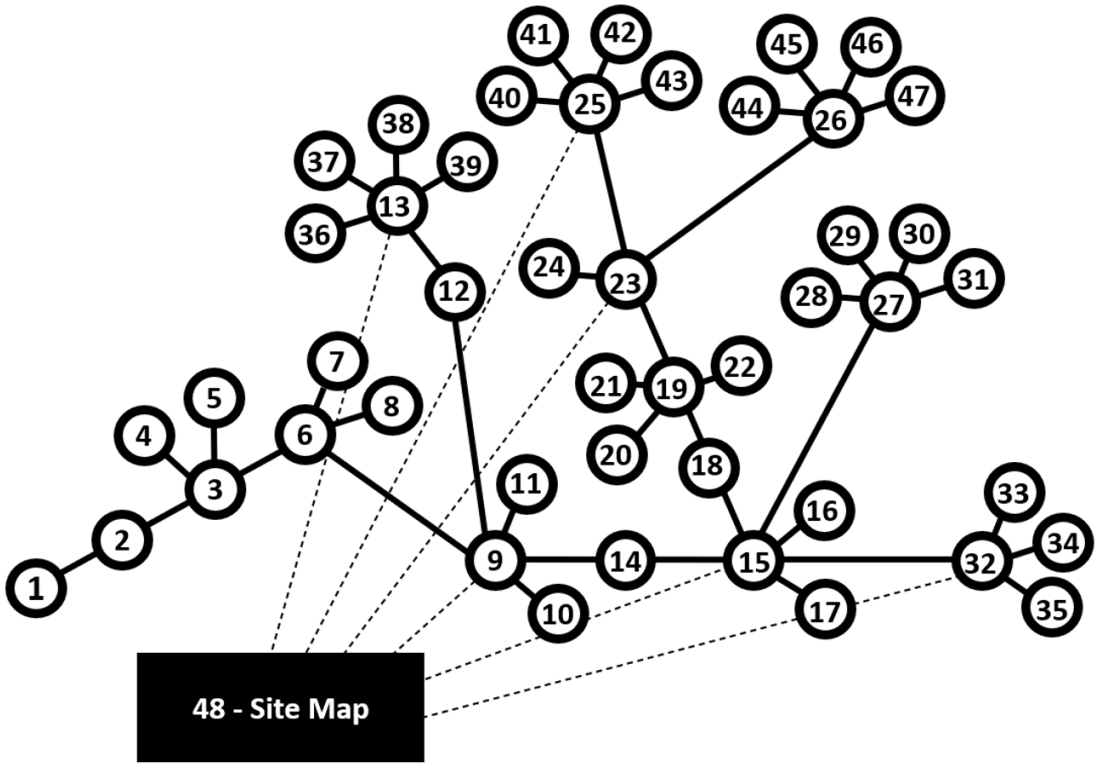


Table 3 - Quantitative results: 'The Last Generation: Climate Change and the Marshall Islands'

Node No	Node Type			Description	Links per node	Anchor points On screen
	I	M	D			
1	1			Start page, begin link	1	1
2		1		Title page	2	1
3	1			Boat video and text	2	1
4		1		Boy video clip	1	1
5	1			Beach and text	2	1
6		1		Girl video clip	1	1
7	1			Beach and text	2	1
8		1		Storm video sequence	1	1
9	1			Introduction end	2	1
10	1			Character selection page	4	4
11		1		Izerman intro video	1	1

12	1			Interactive map	2	1
13		1		Izerman video sequence	1	1
14	1			Beach video clip 'sea snails'	3	2
15			1	Izerman introduction document	0	0
16	1			School clip	2	1
17		1		Izerman school video sequence	1	1
18	1			Animated sequence	3	2
19			1	Izerman text	0	0
20		1		Izerman teacher/school video sequence	1	1
21	1			School clip / crayons	2	1
22			1	Coral photographs	4	3
23		1		Izerman beach/tree video sequence	1	1
24	1			Beach clip and text	2	1
25		1		Izerman beach/dig video sequence	1	1
26	1			Beach clip and text	3	2
27			1	Izerman text	0	0
28		1		Izerman beach/crab video sequence	1	1
29	1			Evening clip	2	1
30		1		Julia intro video sequence	1	1
31	1			Archive and text	2	1
32		1		Julia and archive video sequence	1	1
33	1			Archive and text	3	2
34		1		Archive video sequence	0	0
35		1		Julia and archive video sequence	1	1
36	1			Archive and text	2	1
37			1	Map	2	1
38	1			Interactive map	2	1
39			1	Bomb photos	4	3
40	1			Ejit island and text	3	2
41			1	Anthem lyrics	0	0
42		1		Julia interview video sequence	1	1
43	1			School clip	3	2
44			1	Julia text	0	0
45	1			School clip	2	1
46		1		School video sequence	1	1
47		1		Julia video sequence	1	1
48	1			Interactive statistics	3	2
49			1	Climate statistics	0	0
50	1			Playing clip	2	1
51		1		Julia video sequence ending	1	1

52		1		Wilmer video sequence	1	1
53	1			Flag	2	1
54		1		Wilmer video interview sequence	1	1
55		1		Wilmer video interview sequence	2	1
56	1			Computer lab clip	3	2
57			1	Wilmer text information	0	0
58	1			School clip and text	2	1
59		1		School video interview sequence	1	1
60	1			School clip	2	1
61			1	Water project photos	4	3
62	1			Document selection node	3	2
63			1	Water displacement information	0	0
64	1			School clip	2	1
65		1		School video interview sequence	2	1
66	1			United Nations archive clip	3	2
67		1		United Nations speech video sequence	0	0
68	1			Interactive stats	2	1
69	1			Skipping and text	3	2
70			1	Climate projections	0	0
71		1		Wilmer video interview sequence	1	1
72	1			Science fair clip	2	1
73		1		Science fair video interview sequence (ending)	1	1
Totals	**33**	**27**	**13**		**120**	**82**

Fig 6: An illustration of the structure of The Last Generation

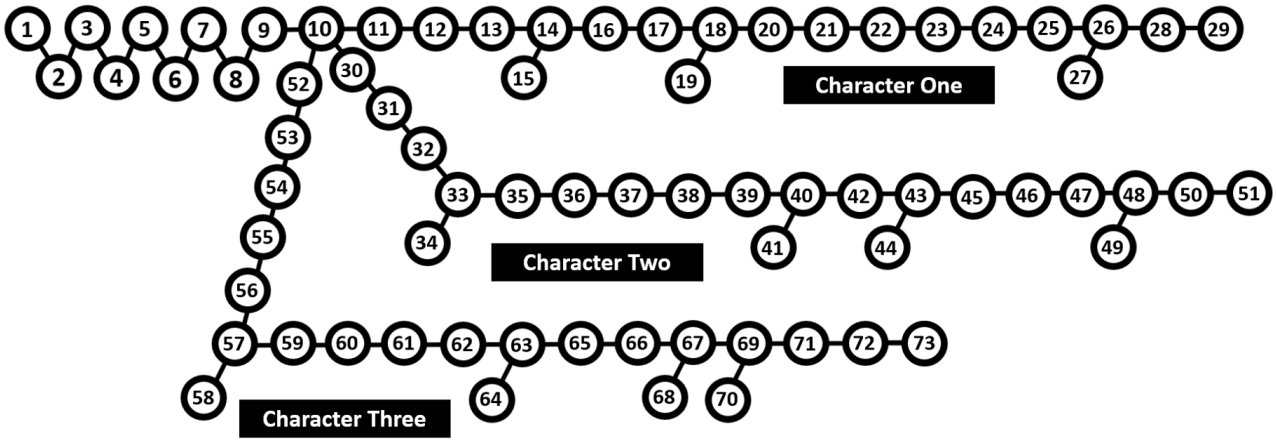


Table 4- Quantitative results: This is Climate Change: Melting Ice

Node	Node Type			Description	Links per node	Anchor points On screen
	I	M	D			
1	1			360 Video – helicopter interior	0	0
2	1			360 Video – helicopter landing	0	0
3	1			360 Video - shelter	0	0
4	1			360 Video – water	0	0
5	1			360 Video – falling ice	0	0
6	1			360 Video – rushing water	0	0
7	1			360 Video - boat	0	0
8	1			360 Video – melting ice	0	0
9	1			360 Video – floating	0	0
10	1			360 Video - flooding	0	0
11	1			360 Video - credits	0	0
Totals	11	0	0		0	0

Fig 7: An illustration of the structure of 'Melting Ice: A Climate Change Story'

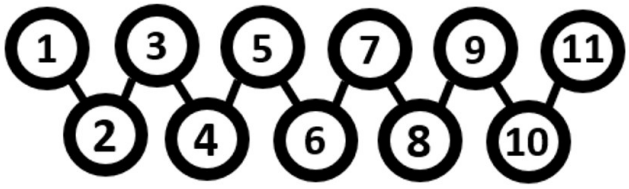


Table 5- Comparison of content and average links per node

	Interactive nodes	Media nodes	Document nodes	Total nodes	Average links per node	Average anchors per node	Average links per interactive node
Offshore	13	28	7	48	1.8	2	6.6
	25%	60%	15%				
Melting ice	11	0	0	11	0	0	0
	100%						
Last Generation	33	27	13	73	1.6	1.1	3.6
	45%	37%	18%				